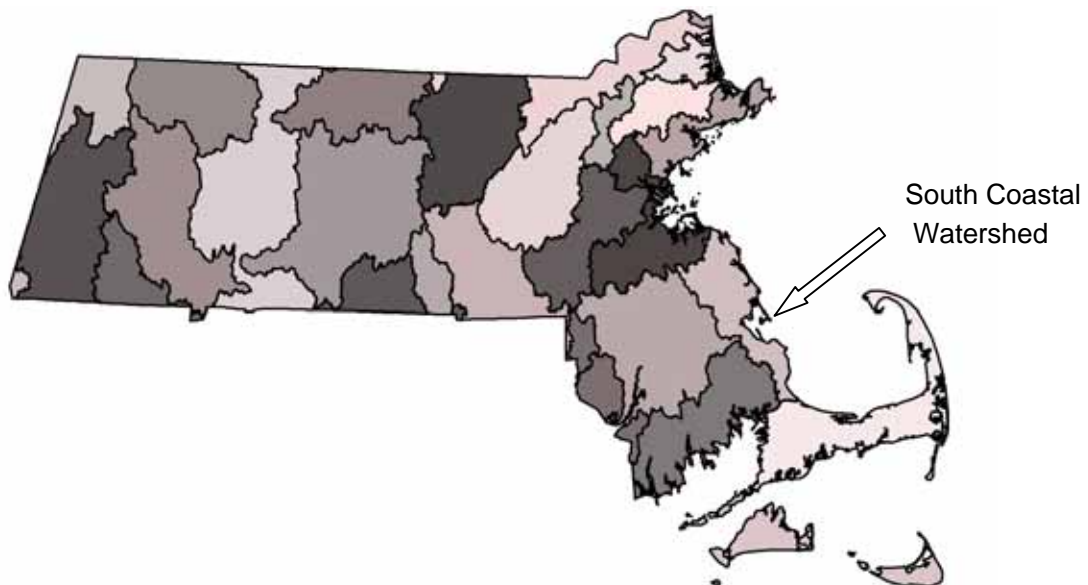


Draft Pathogen TMDL for the South Coastal Watershed



Prepared as a cooperative effort by:

Massachusetts DEP
1 Winter Street
Boston, Massachusetts 02108

USEPA New England Region 1
1 Congress Street, Suite 1100
Boston, Massachusetts 02114



ENSR International
2 Technology Park Drive
Westford, MA 01886

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Limited copies of this report are available at no cost by written request to:

Massachusetts Department of Environmental Protection (MADEP)
Division of Watershed Management
627 Main Street
Worcester, Massachusetts 01608

This report is also available from MADEP's home page on the World Wide Web.

A complete list of reports published since 1963 is updated annually and printed in July. This list, titled "Publications of the Massachusetts Division of Watershed Management (DWM) – Watershed Planning Program, 1963-(current year)", is also available by writing to the DWM in Worcester.

DISCLAIMER

References to trade names, commercial products, manufacturers, or distributors in this report constituted neither endorsement nor recommendations by the Division of Watershed Management for use.

Much of this document was prepared using text and general guidance from the previously approved Neponset River Basin and the Palmer River Basin Bacteria Total Maximum Daily Load documents.

Acknowledgement

This report was developed by ENSR through a partnership with Resource Triangle Institute (RTI) contracting with the United States Environmental Protection Agency (EPA) and the Massachusetts Department of Environmental Protection Agency under the National Watershed Protection Program.

Draft Total Maximum Daily Loads for Pathogens within the South Coastal Watershed



Key Features:	Pathogen TMDL for the South Coastal Watershed
Location:	EPA Region 1
Land Type:	New England Coastal
303(d) Listings:	Pathogens Cohasset Harbor (MA94-01); Scituate Harbor (MA94-02); French Stream (MA94-03); North River (MA94-05); North River (MA94-06); South River (MA94-09); Green Harbor (MA94-11); Jones River (MA94-14); Duxbury Bay (MA94-15); Plymouth Harbor (MA94-16); Plymouth Bay (MA94-17); Herring River (MA94-07).
Data Sources:	NSRWA 2004. River Watch Water Quality Testing Results. North and South Rivers Watershed Association
Data Mechanism:	Massachusetts Surface Water Quality Standards for Fecal Coliform; The Federal BEACH Act; Massachusetts Department of Public Health Bathing Beaches; Massachusetts Division of Marine Fisheries Shellfish Sanitation and Management; Massachusetts Coastal Zone Management
Monitoring Plan:	Massachusetts Watershed Five-Year Cycle; Local Volunteer Groups; Division of Marine Fisheries; Massachusetts Coastal Zone Management
Control Measures:	Watershed Management; Storm Water Management (e.g., illicit discharge removals, public education/behavior modification); CSO & SSO Abatement; Agricultural and other BMPs; No Discharge Areas; By-laws; Ordinances; Septic System Maintenance/Upgrades.

Executive Summary

Purpose and Intended Audience

This document provides a framework to address bacterial and other fecal-related pollution in surface waters of Massachusetts. Fecal contamination of our surface waters is most often a direct result of the improper management of human wastes, excrement from barnyard animals, pet feces and agricultural applications of manure. It can also result from large congregations of birds such as geese and gulls. Illicit discharges of boat waste are of particular concern in coastal areas. Inappropriate disposal of human and animal wastes can degrade aquatic ecosystems and negatively affect public health. Fecal contamination can also result in closures of shellfish beds, beaches, swimming holes and drinking water supplies. The closure of such important public resources can erode quality of life and diminish property values.

Who should read this document?

The following groups and individuals can benefit from the information in this report:

- a) towns and municipalities, especially Phase I and Phase II storm water communities, that are required by law to address storm water and/or combined sewage overflows (CSOs) and other sources of contamination (e.g., broken sewerage pipes and illicit connections) that contribute to a waterbody's failure to meet Massachusetts Water Quality Standards for pathogens;
- b) watershed groups that wish to pursue funding to identify and/or mitigate sources of pathogens in their watersheds;
- c) harbormasters, public health officials and/or municipalities that are responsible for monitoring, enforcing or otherwise mitigating fecal contamination that results in beach and/or shellfish closures or results in the failure of other surface waters to meet Massachusetts standards for pathogens;
- d) citizens that wish to become more aware of pollution issues and may be interested in helping build local support for funding remediation measures.

TMDL Overview

The Massachusetts Department of Environmental Protection (MADEP) is responsible for monitoring the waters of the Commonwealth, identifying those waters that are impaired, and developing a plan to bring them back into compliance with the Massachusetts Water Quality Standards (WQS). The list of impaired waters, better known as the "303d list" identifies problem lakes, coastal waters and specific segments of rivers and streams and the reason for impairment.

Once a water body is identified as impaired, the MADEP is required by the Federal Clean Water Act (CWA) to develop a “pollution budget” designed to restore the health of the impaired body of water. The process of developing this budget, generally referred to as a Total Maximum Daily Load (TMDL), includes identifying the source(s) of the pollutant from direct discharges (point sources) and indirect discharges (non-point sources), determining the maximum amount of the pollutant that can be discharged to a specific water body to meet water quality standards, and assigning pollutant load allocations to the sources. A plan to implement the necessary pollutant reductions is essential to the ultimate achievement of meeting the water quality standards.

Pathogen TMDL: This report represents a TMDL for pathogen indicators (e.g. fecal coliform, *E. coli*, and enterococcus bacteria) in the South Coastal watershed, except Little Harbor estuary (MA94-20) in Cohasset as a TMDL has been previously prepared for this segment in 2002. Certain bacteria, such as coliform, *E. coli*, and enterococcus bacteria, are indicators of contamination from sewage and/or the feces of warm-blooded wildlife (mammals and birds). Such contamination may pose a risk to human health. Therefore, in order to prevent further degradation in water quality and to ensure that waterbodies within the watershed meet state water quality standards, the TMDL establishes indicator bacteria limits and outlines corrective actions to achieve that goal.

Sources of indicator bacteria in the South Coastal watershed were found to be many and varied. Most of the bacteria sources are believed to be storm water related. Table ES-1 provides a general compilation of likely bacteria sources in the South Coastal watershed including failing septic systems, combined sewer overflows, sanitary sewer overflows, sewage pipes connected to storm drains, certain recreational activities, wildlife including birds along with domestic pets and animals and direct overland storm water runoff. Note that bacteria from wildlife would be considered a natural condition unless some form of human inducement, such as feeding, is causing congregation of wild birds or animals. A discussion of pathogen related control measures and best management practices are provided in the companion document: *“Mitigation Measures to Address Pathogen Pollution in Surface Water: A TMDL Implementation Guidance Manual for Massachusetts”*

This TMDL applies to the 12 pathogen impaired segments of the South Coastal watershed that are currently listed on the CWA § 303(d) list of impaired waters. MADEP recommends however, that the information contained in this TMDL guide management activities for all other waters throughout the watershed to help maintain and protect existing water quality. For these non-impaired waters, Massachusetts is proposing “pollution prevention TMDLs” consistent with CWA § 303(d)(3).

The analyses conducted for the pathogen impaired segments in this TMDL would apply to the non-impaired segments, since the sources and their characteristics are equivalent. The waste load and/or load allocation for each source and designated use would be the same as specified herein. Therefore, the pollution prevention TMDLs would have identical waste load and load allocations based on the sources present and the designated use of the water body segment (see Table ES-1 and Table 6-1).

This South Coastal watershed TMDL may, in appropriate circumstances, also apply to segments that are listed for pathogen impairment in subsequent Massachusetts CWA § 303(d) Integrated List of Waters. For such segments, this TMDL may apply if, after listing the waters for pathogen impairment and taking into account all relevant comments submitted on the CWA § 303(d) list, the Commonwealth determines with EPA approval of the CWA § 303(d) list that this TMDL should apply to future pathogen impaired segments.

Since quantitative estimates of existing sources are generally unavailable, it is difficult to estimate the pollutant reductions for specific sources. For the illicit sources, the goal is complete elimination (100% reduction). However, overall wet weather indicator bacteria load reductions can be estimated using typical storm water bacteria concentrations. These data indicate that in general two to three orders of magnitude (i.e., greater than 90%) reductions in storm water fecal coliform loading will be necessary, especially in developed areas. This goal is expected to be accomplished through implementation of best management practices, such as those associated with the Phase II control program for storm water.

TMDL goals for each type of bacteria source are provided in Table ES-1. Municipalities are the primary responsible parties for eliminating many of these sources. TMDL implementation to achieve these goals should be an iterative process with selection and implementation of mitigation measures followed by monitoring to determine the extent of water quality improvement realized. Recommended TMDL implementation measures include identification and elimination of prohibited sources such as leaky or improperly connected sanitary sewer flows and best management practices to mitigate storm water runoff volume. Certain towns in the watershed are classified as Urban Areas by the United States Census Bureau and are subject to the Stormwater Phase II Final Rule that requires the development and implementation of an illicit discharge detection and elimination plan. Combined sewer overflows will be addressed through the on-going long-term control plans.

In most cases, authority to regulate non-point source pollution and thus successful implementation of this TMDL is limited to local government entities and will require cooperative support from local volunteers, watershed associations, and local officials in municipal government. Those activities can take the form of expanded education, obtaining and/or providing funding, and possibly local enforcement. In some cases, such as subsurface disposal of wastewater from homes, the Commonwealth provides the framework, but the administration occurs on the local level. Federal and state funds to help implement this TMDL are available, on a competitive basis, through the Non-Point Source Control (CWA Section 319) Grants, Water Quality (CWA Section 604(b)) Grants, and the State Revolving (Loan) Fund Program (SRF). Most financial aid requires some local match as well. The programs mentioned are administered through the MADEP. Additional funding and resources available to assist local officials and community groups can be referenced within the Massachusetts Non-point Source Management Plan-Volume I Strategic Summary (2000) "Section VII Funding / Community Resources". This document is available on the MADEP's website at: www.state.ma.us/dep/brp/wm/wmpubs.htm, or by contacting the MADEP's Nonpoint Source Program at (508) 792-7470 to request a copy.

Table ES-1. Sources and Expectations for Limiting Bacterial Contamination in the South Coastal Watershed.

Surface Water Classification	Pathogen Source	Waste Load Allocation Indicator Bacteria (CFU/100 mL)¹	Load Allocation Indicator Bacteria (CFU/100 mL)¹
A, B, SA, SB	<ul style="list-style-type: none"> Illicit discharges to storm drains Leaking sanitary sewer lines 	0	N/A
A, B, SA, SB	Failing septic systems	N/A	0
A	<ul style="list-style-type: none"> NPDES Storm water runoff Phase I and II 	Not to exceed an arithmetic mean of 20 organisms in any set of representative samples nor shall 10% of the samples exceed 100 organisms ²	N/A
A	Direct storm water runoff not regulated by NPDES and livestock, wildlife & pets	N/A	Not to exceed an arithmetic mean of 20 organisms in any set of representative samples nor shall 10% of the samples exceed 100 organisms ³
B & SA & SB Not Designated for Shellfishing	<ul style="list-style-type: none"> CSOs NPDES – WWTP Storm water runoff Phase I and II 	Shall not exceed a geometric mean of 200 organisms in any set of representative samples, nor shall 10% of the samples exceed 400 organisms ⁴	N/A
B & SA & SB Not Designated for Shellfishing	Direct storm water runoff not regulated by NPDES and livestock, wildlife & pets	N/A	Not to exceed a geometric mean of 200 organisms in any set of representative samples, nor shall 10% of the samples exceed 400 organisms ³
SA Designated Shellfishing Areas	<ul style="list-style-type: none"> NPDES – WWTP Storm water Runoff Phase I and II 	Not to exceed a geometric mean of 14 organisms in any set of representative samples, nor shall 10% of the samples exceed 43 organisms ²	N/A
SA Designated Shellfishing Areas	Direct storm water runoff not regulated by NPDES and livestock, wildlife & pets	N/A	Not to exceed a geometric mean of 14 organisms in any set of representative samples, nor shall 10% of the samples exceed 43 organisms ³
SB Designated Shellfishing Areas	<ul style="list-style-type: none"> CSOs NPDES – WWTP Storm water runoff Phase I and II 	Not to exceed a geometric mean of 88 organisms in any set of representative samples, nor shall 10% of the samples exceed 260 organisms ⁴	N/A
SB Designated Shellfishing Areas	Direct storm water runoff not regulated by NPDES and livestock, wildlife & pets	N/A	Not to exceed a geometric mean of 88 organisms in any set of representative samples, nor shall 10% of the samples exceed 260 organisms ³

Table ES-1 (continued). Sources and Expectations for Limiting Bacterial Contamination in the South Coastal Watershed.

Surface Water Classification	Pathogen Source	Waste Load Allocation Indicator Bacteria (CFU/100 mL)¹	Load Allocation Indicator Bacteria (CFU/100 mL)¹
No Discharge Areas	Vessels – raw or treated sanitary waste	0	N/A
Marine Beaches ⁵	All Sources	Enterococci not to exceed a geometric mean of 35 colonies in a statistically significant number of samples, nor shall any single sample exceed 104 colonies	Enterococci not to exceed a geometric mean of 35 colonies in a statistically significant number of samples, nor shall any single sample exceed 104 colonies
Fresh Water Beaches ⁶	All Sources	Enterococci not to exceed a geometric mean of 33 colonies of the five most recent samples within the same bathing season, nor shall any single sample exceed 61 colonies OR <i>E. coli</i> not to exceed a geometric mean of 126 colonies of the five most recent samples within the same bathing season, nor shall any single sample exceed 235 colonies	Enterococci not to exceed a geometric mean of 33 colonies of the five most recent samples within the same bathing season, nor shall any single sample exceed 61 colonies OR <i>E. coli</i> not to exceed a geometric mean of 126 colonies of the five most recent samples within the same bathing season, nor shall any single sample exceed 235 colonies

N/A means not applicable

¹ Waste Load Allocation (WLA) and Load Allocation (LA) refer to fecal coliform densities unless specified in table.

² Or shall be consistent with the Waste Water Treatment Plant (WWTP) National Pollutant Discharge Elimination System (NPDES) permit.

³The expectation for WLAs and LAs for storm water discharges is that they will be achieved through the implementation of BMPs and other controls.

⁴ Or shall be consistent with an approved Long Term Control Plan (LTCP) for Combined Sewer Overflow (CSO) abatement. If the level of control specified in the LTCP is less than what is necessary to attain Class B water quality standards, then the above criteria apply unless MADEP has proposed and EPA has approved water quality standards revisions for the receiving water.

⁵ Federal Beaches Environmental Assessment and Coastal Health Act of 2000 (BEACH Act) Water Quality Criteria

⁶ Massachusetts Department of Public Health regulations (105 CMR Section 445)

Note: this table represents waste load and load reductions based on water quality standards current as of the publication date of these TMDLs, any future changes made to the Massachusetts water quality standards will become the governing water quality standards for these TMDLs.

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**Appendix A Lower Charles River Illicit Discharge Detection & Elimination (IDDE)
Protocol Guidance for Consideration - November 2004**

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1.0 Introduction

Section 303(d) of the Federal Clean Water Act (CWA) and Environmental Protection Agencies (EPA's) Water Quality Planning and Management Regulations (40 CFR Part 130) require states to place waterbodies that do not meet established water quality standards on a list of impaired waterbodies (commonly referred to as the "303d List") and to develop Total Maximum Daily Loads (TMDLs) for listed waters and the pollutant(s) contributing to the impairment. In Massachusetts, impaired waterbodies are included in Category 5 of the "*Massachusetts Year 2002 Integrated List of Water: Part 2- Final Listing of Individual Categories of Waters*" (2002 List; MADEP 2003). Figure 1-1 provides a map of the South Coastal watershed with pathogen impaired segments indicated. Please note that not all segments have been assessed by the Massachusetts Department of Environmental Protection (MADEP) for pathogen impairment. As shown in Figure 1-1, several South Coastal waterbodies are listed as a Category 5 "impaired or threatened for one or more uses and requiring a TMDL" due to excessive indicator bacteria concentrations.

TMDLs are to be developed for water bodies that are not meeting designated uses under technology-based controls only. TMDLs determine the amount of a pollutant that a waterbody can safely assimilate without violating water quality standards. The TMDL process establishes the maximum allowable loading of pollutants or other quantifiable parameters for a waterbody based on the relationship between pollutant sources and instream conditions. The TMDL process is designed to assist states and watershed stakeholders in the implementation of water quality-based controls specifically targeted to identified sources of pollution in order to restore and maintain the quality of their water resources (USEPA 1999). TMDLs allow watershed stewards to establish measurable water quality goals based on the difference between site-specific instream conditions and state water quality standards.

A major goal of this TMDL is to achieve meaningful environmental results with regard to the designated uses of the South Coastal waterbodies. These include water supply, shellfish harvesting, fishing, boating, and swimming. This TMDL establishes the necessary pollutant load (as defined by concentration) to achieve designated uses and water quality standard and the companion document entitled; "*Mitigation Measures to Address Pathogen Pollution in Surface Water: A TMDL Implementation Guidance Manual for Massachusetts*" provides guidance for the implementation of this TMDL.

Historically, water and sediment quality studies have focused on the control of point sources of pollutants (i.e., discharges from pipes and other structural conveyances) that discharge directly into well-defined hydrologic resources, such as lakes, ponds, or river segments. While this localized approach may be appropriate under certain situations, it typically fails to characterize the more subtle and chronic sources of pollutants that are widely scattered throughout a broad geographic region such as a watershed (e.g., roadway runoff, failing septic systems in high groundwater, areas of concentrated wildfowl use, fertilizers, pesticides, pet waste, and certain agricultural sources). These so called nonpoint sources of pollution often contribute significantly to the decline of water quality through their cumulative impacts. A watershed-level approach that uses the surface drainage area as the basic study unit enables managers to gain a more complete understanding of the

Figure 1-1. South Coastal Watershed and Pathogen Impaired Segments.

potential pollutant sources impacting a waterbody and increases the precision of identifying local problem areas or “hot spots” which may detrimentally affect water and sediment quality. It is within this watershed-level framework that the Massachusetts Department of Environmental Protection (MADEP) commissioned the development of watershed based TMDLs.

1.1. Pathogens and Indicator Bacteria

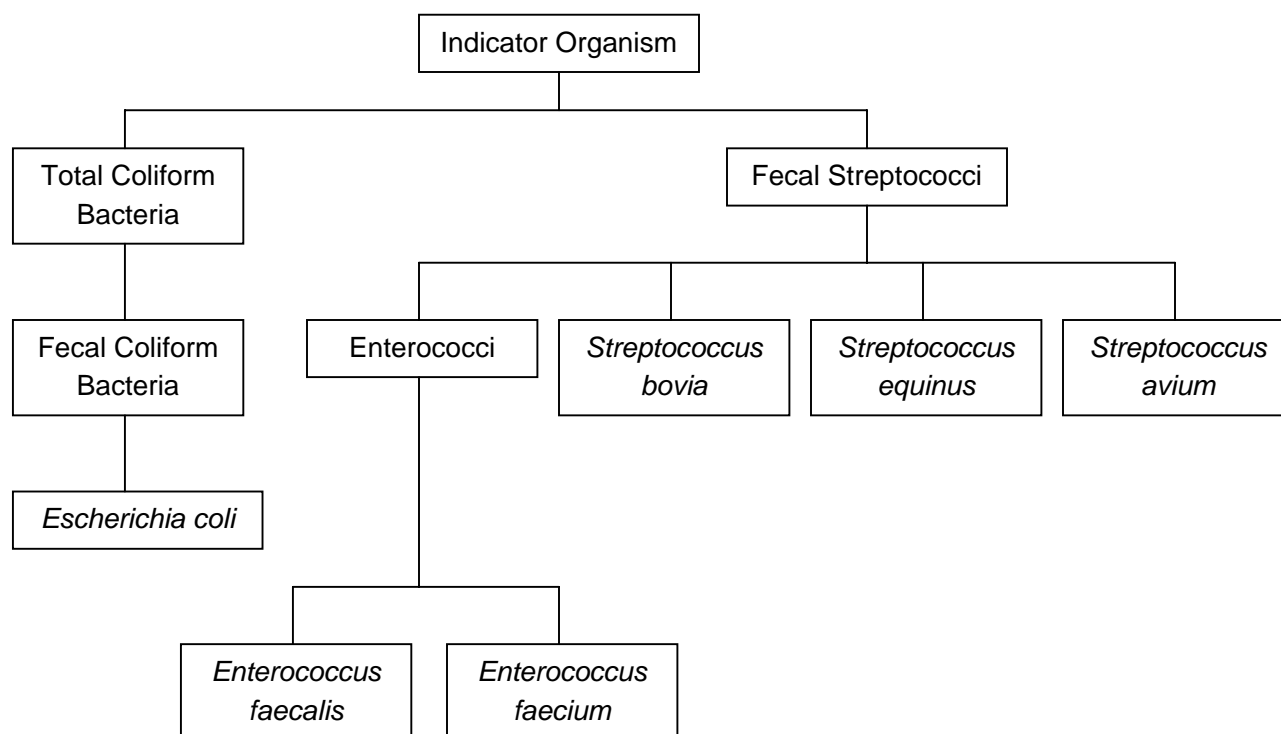
The South Coastal watershed pathogen TMDL is designed to support reduction of waterborne disease-causing organisms, known as pathogens, to reduce public health risk. Waterborne pathogens enter surface waters from a variety of sources including sewage and the feces of warm-blooded wildlife. These pathogens can pose a risk to human health due to gastrointestinal illness through exposure via ingestion and contact with recreational waters, ingestion of drinking water, and consumption of filter-feeding shellfish.

Waterborne pathogens include a broad range of bacteria and viruses that are difficult to identify and isolate. Thus, specific nonpathogenic bacteria have been identified that are typically associated with harmful pathogens in fecal contamination. These associated nonpathogenic bacteria are used as indicator bacteria as they are easier to identify and measure in the environment. High densities of indicator bacteria increase the likelihood of the presence of pathogenic organisms.

Selection of indicator bacteria is difficult as new technologies challenge current methods of detection and the strength of correlation of indicator bacteria and human illness. Currently, coliform and fecal streptococci bacteria are commonly used as indicators of potential pathogens (i.e., indicator bacteria). Coliform bacteria include total coliforms, fecal coliform and *Escherichia coli* (*E. coli*). Fecal coliform (a subset of total coliform) and *E. coli* (a subset of fecal coliform) bacteria are present in the intestinal tracts of warm blooded animals. Presence of coliform bacteria in water indicates fecal contamination and the possible presence of pathogens. Fecal streptococci bacteria are also used as indicator bacteria, specifically enterococci a subgroup of fecal streptococci. These bacteria also live in the intestinal tract of animals, but their presence is a better predictor of human gastrointestinal illness than fecal coliform since the die-off rate of enterococci is much lower (i.e., enterococci bacteria remain in the environment longer) (USEPA 2001). The relationship of indicator organisms is provided in Figure 1-2. The EPA, in the “*Ambient Water Quality Criteria for Bacteria – 1986*” document, recommends the use of *E. coli* or enterococci as potential pathogen indicators in fresh water and enterococci in marine waters (USEPA 1986).

Massachusetts uses fecal coliform and enterococci as indicator organisms of potential harmful pathogens. The water quality standards (WQS) that apply for fresh water are currently based on fecal coliform concentration but will be replaced with *E. coli* during the Water Quality Standards Revision process which is presently underway. Fecal coliform are also used by the Massachusetts Division of Marine Fisheries (DMF) in their classification of shellfish growing areas. Fecal coliform as the indicator organism for shellfish growing area status is not expected to change in the standards at this time. Enterococci are used as the indicator organism for marine beaches, as required by the federal Beaches Environmental Assessment and Coastal Act of 2000 (BEACH Act), an amendment to the CWA.

Figure 1-2. Relationships among Indicator Organisms (USEPA 2001).



The South Coastal watershed pathogen TMDLs have been developed using fecal coliform as an indicator bacterium for fresh and marine waters and enterococci for marine beaches. Any changes in the Massachusetts pathogen water quality standard will apply to this TMDL at the time of the standard change. Massachusetts believes that the magnitude of indicator bacteria reductions outlined in this TMDL will be both necessary and sufficient to attain present WQS and any future modifications to the WQS for pathogens.

1.2. Comprehensive Watershed-based Approach to TMDL Development

Consistent with Section 303(d) of the CWA, the MADEP has chosen to complete pathogen TMDLs for all waterbodies in the South Coastal watershed at this time, regardless of current impairment status (i.e., for all waterbody categories in the *2002 List*). MADEP believes a comprehensive management approach carried out by all watershed communities is needed to address the ubiquitous nature of pathogen sources present in the South Coastal watershed. Watershed-wide implementation is needed to meet WQS and restore designated uses in impaired segments while providing protection of desirable water quality in waters that are not currently impaired or not assessed.

As discussed below, this TMDL applies to the 12 pathogen impaired segments of the South Coastal watershed that are currently listed on the CWA § 303(d) list of impaired waters. MADEP recommends however, that the information contained in this TMDL guide management activities for

all other waters throughout the watershed to help maintain and protect existing water quality. For these non-impaired waters, Massachusetts is proposing “pollution prevention TMDLs” consistent with CWA § 303(d)(3).

The analyses conducted for the pathogen impaired segments in this TMDL would apply to the non-impaired segments, since the sources and their characteristics are equivalent. The waste load and/or load allocation for each source and designated use would be the same as specified herein. Therefore, the pollution prevention TMDLs would have identical waste load and load allocations based on the sources present and the designated use of the water body segment (see Table ES-1 and Table 6-1).

This South Coastal watershed TMDL may, in appropriate circumstances, also apply to segments that are listed for pathogen impairment in subsequent Massachusetts CWA § 303(d) Integrated List of Waters. For such segments, this TMDL may apply if, after listing the waters for pathogen impairment and taking into account all relevant comments submitted on the CWA § 303(d) list, the Commonwealth determines with EPA approval of the CWA § 303(d) list that this TMDL should apply to future pathogen impaired segments.

There are 103 waterbody segments assessed by the MADEP in the South Coastal watershed (MassGIS 2005). These segments include 14 estuary segments, nine river segments, and 80 lake segments. Twelve of the 14 estuary and one of the nine river segments are pathogen impaired and appear as such on the official list of impaired watershed (303(d) List) (Figure 1-1). A pathogen TMDL has been previously prepared and approved for the Little Harbor (MA94-20) estuary segment located in Cohasset. Pathogen impairment has been documented by the MADEP in previous reports (e.g., *2002 List*). In this TMDL document, an overview of pathogen impairment is provided to illustrate the nature and extent of the pathogen impairment problem. Additional data, not collected by the MADEP or used to determine impairment status, are also provided in this TMDL to illustrate the pathogen problem. Since pathogen impairment has been previously established only a summary is provided herein.

The watershed based approach applied to complete the South Coastal watershed pathogen TMDL is straightforward. The approach is focused on identification of sources, source reduction, and implementation of appropriate management plans. Once identified, sources are required to meet applicable WQS for indicator bacteria or be eliminated. This approach does not include water quality analysis or other approaches designed to link ambient concentrations with source loadings. For pathogens and indicator bacteria, water quality analyses are generally resource intensive and provide results with large degrees of uncertainty. Rather, this approach focuses on sources and required load reductions, proceeding efficiently toward water quality restoration activities.

The implementation strategy for reducing indicator bacteria is an iterative process where data are gathered on an ongoing basis, sources are identified and eliminated if possible, and control measures including Best Management Practices (BMPs) are implemented, assessed and modified

as needed. Measures to abate probable sources of waterborne pathogens include everything from public education, to improved storm water management, to reducing the influence from inadequate and/or failing sanitary sewer infrastructure.

1.3. TMDL Report Format

This document contains the following sections:

- Watershed Description (Section 2) - provides watershed specific information
- Water Quality Standards (Section 3) – provides a summary of current Massachusetts WQS as they relate to indicator bacteria
- Problem Assessment (Section 4) – provides an overview of indicator bacteria measurements collected in the South Coastal watershed
- Identification of Sources (Section 5) – identifies and discusses potential sources of waterborne pathogens within the South Coastal watershed
- TMDL Development (Section 6) – specifies required TMDL development components including:
 - Definitions and Equation
 - Loading Capacity
 - Load and Waste Load Allocations
 - Margin of Safety
 - Seasonal Variability
- Implementation Plan (Section 7) – describes specific implementation activities designed to remove pathogen impairment. This section and the companion “*Mitigation Measures to Address Pathogen Pollution in Surface Water: A TMDL Implementation Guidance Manual for Massachusetts*” document should be used together to support implementing management actions.
- Monitoring Plan (Section 8) – describes recommended monitoring activities
- Reasonable Assurances (Section 9) – describes reasonable assurances the TMDL will be implemented
- Public Participation (Section 10) – describes the public participation process, and
- References (Section 11)

2.0 Watershed Description

The South Coastal watershed drains approximately 240.7 square miles of the Massachusetts' southshore. All or part of 19 Commonwealth communities are within the South Coastal Drainage area (EOEA 2003a). The drainage boundary extends from Cohasset to Sandwich including all or part of the following communities: Cohasset, Scituate, Norwell, Hingham, Rockland, Weymouth, Hanover, Abington, Hanson, Pembroke, Duxbury, Marshfield, Kingston, Plymouth, Bourne, Sandwich, Halifax, Plympton and Whitman. The watershed is made up of four main river systems, North River, South River, Jones River, and Gulf/Bound Brook (EOEA 2003a). "The South Coastal Watersheds contain numerous wetlands, many of which are used to cultivate cranberries. There are also many small coastal plain lakes and ponds scattered throughout the basin, numbering more than 350, 56 of which cover at least ten acres." (EOEA 2003a)

The South Coastal watershed contains extensive areas of open space, rural towns, and highly urbanized communities (Table 2-1; Figure 2-1). Surface waters in the watershed are commonly used for primary and secondary contact recreation (swimming and boating), public drinking water, viewing wildlife, habitat for aquatic life, lobster fishing, shellfishing and beachfront. Locations of public and semi-public marine beaches are illustrated on Figure 2-2. Detailed information regarding water quality at swimming beaches (both fresh and marine waters) can be obtained from the beach quality annual reports available for download at the Massachusetts Department of Public Health website (<http://www.mass.gov/dph/beha/tox/reports/beach/beaches.htm>).

There are no offshore areas protected against the disposal of treated or untreated sewage from vessels in this watershed (i.e., No Discharge Areas; see Section 7.8 for additional information regarding this designation) (Figure 2-3).

Table 2-1. South Coastal Watershed Land Use as of 1999.

Land Use Category	% of Total Watershed Area
Pasture	0.7
Urban Open	1.3
Open Land	2.6
Cropland	0.8
Woody Perennial	2.2
Forest	48.5
Wetland/Salt Wetland	5.4
Water Based Recreation	0.3
Water	3.5
General Undeveloped Land	65.5
Spectator Recreation	<0.1
Participation Recreation	1.5
> 1/2 acre lots Residential	15.3
1/4 - 1/2 acre lots Residential	10.8
< 1/4 acre lots Residential	1.8
Multi-family Residential	0.5
Mining	0.7
Commercial	1.6
Industrial	0.8
Transportation	1.3
Waste Disposal	0.1
General Developed Land	34.5

Figure 2-1. South Coastal Watershed Land Use as of 1999.

Figure 2-2. South Coastal Watershed Marine Beach Locations and Pathogen Impaired Segments.

Figure 2-3. General Location of Massachusetts' No Discharge Areas (USEPA 2004a).



3.0 Water Quality Standards

The Surface Water Quality Standards (WQS) for the Commonwealth of Massachusetts establish chemical, physical and biological standards for the restoration and maintenance of the most sensitive uses (MADEP 2000a). The WQS limit the discharge of pollutants to surface waters for the protection of existing uses and attainment of designated uses in downstream and adjacent segments.

Fecal coliform, enterococci, and *E. coli* bacteria are found in the intestinal tract of warm-blooded animals, soil, water, and certain food and wood processing wastes. “Although they are generally not harmful themselves, they indicate the possible presence of pathogenic (disease-causing) bacteria, viruses, and protozoans that also live in human and animal digestive systems.” (USEPA 2004b) These bacteria are often used as indicator bacteria since it is expensive and sometimes difficult to test for the presence of individual pathogenic organisms.

Massachusetts is planning to revise its freshwater WQS by replacing fecal coliform with *E. coli* and enterococci as the regulated indicator bacteria, as recommended by the EPA in the “*Ambient Water Quality Criteria for Bacteria – 1986*” document (USEPA 1986). The state has already done so for public beaches through regulations of the Massachusetts Department of Public Health as discussed below. Currently, Massachusetts uses fecal coliform as the indicator organism for all waters except for marine bathing beaches, where the Federal BEACH Act requires the use of enterococci. Massachusetts anticipates adopting *E. coli* and enterococci for all fresh waters and enterococci for all marine waters, including non bathing marine beaches. Fecal coliform will remain the indicator organism for shellfishing areas, however. The South Coastal watershed pathogen TMDL has been developed using fecal coliform as the pathogen indicator for fresh and marine waters and enterococci for marine beaches, but the goal of removing pathogen impairment of this TMDL will remain applicable when Massachusetts adopts new indicator bacteria criteria into its WQS. Massachusetts believes that the magnitude of indicator bacteria loading reductions outlined in this TMDL will be both necessary and sufficient to attain present WQS and any future modifications to the WQS for pathogens.

Pathogens can significantly impact humans through ingestion of, and contact with recreational waters, ingestion of drinking water, and consumption of filter-feeding shellfish. In addition to contact recreation, excessive pathogen numbers impact potable water supplies. The amount of treatment (i.e., disinfection) required to produce potable water increases with increased pathogen contamination. Such treatment may cause the generation of disinfection by-products that are also harmful to humans. Further detail on pathogen impacts can be accessed at the following EPA websites:

- Water Quality Criteria: Microbial (Pathogen)
<http://www.epa.gov/ost/humanhealth/microbial/microbial.html>
- Human Health Advisories:
 - Fish and Wildlife Consumption Advisories
<http://www.epa.gov/ebtpages/humaadvisofishandwildlifeconsumption.html>

- Swimming Advisories
<http://www.epa.gov/ebtpages/humaadvisoswimmingadvisories.html>

The South Coastal watershed contains waterbodies classified as Class A, Class B, Class SA, and Class SB. The corresponding WQS for each class are as follows:

Class A waterbodies - fecal coliform bacteria shall not exceed an arithmetic mean of 20 organisms per 100 mL in any representative set of samples, nor shall 10% of the samples exceed 100 organisms per 100 mL.

Class B and Class SA and SB not designated for shellfishing - the geometric mean of a representative set of fecal coliform samples shall not exceed 200 organisms per 100 mL and no more than 10% of the samples shall exceed 400 organisms per 100 mL. The MADEP may apply these standards on a seasonal basis for waters classified as Class B, and Class SA and SB not designated for shellfishing.

Class SA waters approved for open shellfishing - the geometric mean of a representative set of fecal coliform samples shall not exceed 14 organisms per 100 mL and no more than 10% of the samples shall exceed 43 organisms per 100 mL.

Class SB waters approved for open shellfishing - the geometric mean of a representative set of fecal coliform samples shall not exceed 88 organisms per 100 mL and no more than 10% of the samples shall exceed 260 organisms per 100 mL.

Shellfish growing areas are classified by the Massachusetts Division of Marine Fisheries (DMF). The classification system is provided below (MassGIS 2005). Figure 1-1 provides designated shellfish growing areas status as of July 1, 2000.

Approved – “Open for harvest of shellfish for direct human consumption subject to local rules and state regulations.” (MassGIS 2005) “The area is shown to be free of bacterial contaminants under a variety of climatological and hydrographical situations (i.e. assumed adverse pollution conditions).” (MADEP 2002a)

Conditionally Approved - “During the time area is approved it is open for harvest of shellfish for direct human consumption subject to local rules and state regulations.” (MassGIS 2005) “This classification category may be assigned for growing areas subject to intermittent and predictable microbiological contamination that may be present due to operation of a sewage treatment plant, rainfall, and/or season.” (MADEP 2002a)

Conditionally Restricted – “During the time area is restricted it is only open for the harvest of shellfish with depuration subject to local rules and state regulations.” (MassGIS 2005) “A classification used to identify a growing area that meets the criteria for the restricted classification except under certain conditions described in a management plan.” (MADEP 2002a)

Restricted – “Open for harvest of shellfish with depuration subject to local rules and state regulations or for the relay of shellfish.” (MassGIS 2005) “A classification used to identify where harvesting shall be by special license and the shellstock, following harvest, is subject to a suitable and effective treatment process through relaying or depuration. Restricted growing areas are mildly or moderately contaminated only with bacteria.” (MADEP 2002a)

Management Closure – “Closed for the harvest of shellfish. Not enough testing has been done in the area to determine whether it is fit for shellfish harvest or not.” (MADEP 2002a)

Prohibited – “Closed for harvest of shellfish.” (MassGIS 2005) “A classification used to identify a growing area where the harvest of shellstock is not permitted. Growing area waters are so badly contaminated that no reasonable amount of treatment will make the shellfish safe for human consumption. Growing areas must also be classified as Prohibited if there is no or insufficient information available to make a classification decision.” (MADEP 2002a).

In general, shellfish harvesting use is supported (i.e., non-impaired) when shellfish harvested from approved open shellfish areas are suitable for consumption without depuration and shellfish harvested from restricted shellfish areas are suitable for consumption with depuration. For an expanded discussion on the relationship between the DMF shellfish growing areas classification and the MADEP designated use support status, please see any of the completed MADEP Water Quality Assessment Reports available on the worldwide web (for example the “*Buzzards Bay Watershed 2000 Water Quality Assessment Report*” available at <http://www.mass.gov/dep/brp/wm/wqassess.htm>). A Water Quality Assessment Report for the South Coastal watershed is currently being prepared by the MADEP at this time.

In addition to the WQS, the Commonwealth of Massachusetts Department of Public Health (MADPH) has established minimum standards for bathing beaches (105 CMR 445.000) under the State Sanitary Code, Chapter VII (www.mass.gov/dph/dcs/bb4_01.pdf). These standards will soon be adopted by the MADEP as state surface WQS for fresh water and these standards will subsequently apply to this TMDL. The MADPH bathing beach standards are generally the same as those which were recommended in the “*Ambient Water Quality Criteria for Bacteria – 1986*” document published by the EPA (USEPA 1986). In the above referenced document, the EPA recommended the use of enterococci as the indicator bacterium for marine recreational waters and enterococci or *E. coli* for fresh waters. As such, the following MADPH standards have been established for bathing beaches in Massachusetts:

Marine Waters - (1) No single enterococci sample shall exceed 104 colonies per 100 mL and the geometric mean of the most recent five enterococci levels within the same bathing season shall not exceed 35 colonies per 100 mL.

Freshwaters - (1) No single *E. coli* sample shall exceed 235 colonies per 100 mL and the geometric mean of the most recent five *E. coli* samples within the same bathing season shall not exceed 126 colonies per 100 mL; or (2) No single enterococci sample shall exceed 61

colonies per 100 mL and the geometric mean of the most recent five enterococci samples within the same bathing season shall not exceed 33 colonies per 100 mL.

The Federal BEACH Act of 2000 established a Federal standard for marine beaches. These standards are essentially the same as the MADPH marine beach standard (i.e., single sample not to exceed 104 cfu/100mL and geometric mean of a statistically sufficient number of samples not to exceed 35 cfu/100mL). The Federal BEACH Act and MADPH standards can be accessed on the worldwide web at <http://www.epa.gov/waterscience/beaches/act.html> and www.mass.gov/dph/dcs/bb4_01.pdf, respectively.

Figure 2-2 provides the location of marine bathing beaches, where the MADPH Marine Waters and the Federal BEACH Act standards would apply. A map of freshwater beaches is not available at this time. However, a list of beaches (fresh and marine) by community with indicator bacteria data can be found in the annual reports on the testing of public and semi-public beaches provided by the MADPH. These reports are available for download from the MADPH website located at <http://www.mass.gov/dph/beha/tox/reports/beach/beaches.htm>.

4.0 Problem Assessment

Pathogen impairment has been documented at numerous locations throughout the South Coastal watershed, as shown in Figure 1-1. Excessive concentrations of indicator bacteria (e.g., fecal coliform, enterococci, *E. coli* etc.) can indicate the presence of sewage contamination and possible presence of pathogenic organisms. The amount of indicator bacteria and potential pathogens entering waterbodies is dependent on several factors including watershed characteristics and meteorological conditions. Indicator bacteria levels generally increase with increasing development activities, including increased impervious cover, illicit sewer connections, and failed septic systems.

Indicator bacteria levels also tend to increase with wet weather conditions as storm sewer systems overflow and/or storm water runoff carries fecal matter that has accumulated to the river via overland flow and storm water conduits. In some cases, dry weather bacteria concentrations can be higher when there is a constant source that becomes diluted during periods of precipitation, such as with illicit connections. The magnitude of these relationships is variable, however, and can be substantially different temporally and spatially throughout the United States or within each watershed.

Tables 4-1 and 4-2 provide ranges of fecal coliform concentrations in storm water associated with various land use types. Pristine areas are observed to have low indicator bacteria levels and residential areas are observed to have elevated indicator bacteria levels. Development activity generally leads to decreased water quality (e.g., pathogen impairment) in a watershed. Development-related watershed modification includes increased impervious surface area which can (USEPA 1997):

- increase flow volume,
- increase peak flow,
- increase peak flow duration,
- increase stream temperature,
- decrease base flow, and
- change sediment loading rates.

Many of the impacts associated with increased impervious surface area also result in changes in pathogen loading (e.g., increased sediment loading can result in increased pathogen loading). In addition to increased impervious surface impacts, increased human and pet densities in developed areas increase potential fecal contamination. Furthermore, storm water drainage systems and associated storm water culverts and outfall pipes often result in the channelization of streams which leads to less attenuation of pathogen pollution.

Table 4-1. Wachusett Reservoir Storm Water Sampling (as reported in MADEP 2002b) original data provided in MDC Wachusett Storm Water Study (June 1997)

Land Use Category	Fecal Coliform Bacteria¹ Organisms / 100 mL
Agriculture, Storm 1	110 - 21,200
Agriculture, Storm 2	200 - 56,400
"Pristine" (not developed, forest), Storm 1	0 - 51
"Pristine" (not developed, forest), Storm 2	8 - 766
High Density Residential (not sewered, on septic systems), Storm 1	30 - 29,600
High Density Residential (not sewered, on septic systems), Storm 2	430 - 122,000

¹ Grab samples collected for four storms between September 15, 1999 and June 7, 2000

Table 4-2. Lower Charles River Basin Storm Water Event Mean Bacteria Concentrations (data summarized from USGS 2002)¹

Land Use Category	Fecal Coliform (CFU/100 mL)	Enterococcus Bacteria (CFU/100 mL)	Number of Events
Single Family Residential	2,800 – 94,000	5,500 – 87,000	8
Multifamily Residential	2,200 – 31,000	3,200 – 49,000	8
Commercial	680 – 28,000	2,100 – 35,000	8

¹ An Event Mean Concentration (EMC) is the concentration of a flow proportioned sample throughout a storm event. These samples are commonly collected using an automated sampler which can proportion sample aliquots based on flow.

Pathogen impaired estuary segments represent 99.0% of the total estuary area assessed (20.7 impaired square miles; 20.9 total square miles assessed; includes areas associated with one estuary with an existing pathogen TMDL). Pathogen impaired river segments represents 18.2% of the total river miles assessed (5.9 impaired miles; 32.4 total miles assessed). In total, 12 segments, each in need of a TMDL, contain indicator bacteria concentrations in excess of the Massachusetts WQS for Class A, SA, B, or SB waterbodies (314 CMR 4.05)¹, the MADPH standard for bathing beaches², and/or the BEACH Act³. The basis for impairment listings is provided in the *2002 List* (MADEP 2003). Data collected by the MADEP were used to generate the *2002 List*.

A list of pathogen impaired segments requiring TMDLs is provided in Table 4-3. This TMDL does not, however, apply to Little Harbor (MA94-20) in Cohasset, as a pathogen TMDL for this segment has been previously developed.

An overview of the South Coastal watershed pathogen impairment is provided in this section to illustrate the nature and extent of the impairment. Since pathogen impairment has been previously established and documented on the *2002 List*, it is not necessary to provide detailed documentation of pathogen impairment herein. Data from the North and South Rivers Watershed Association (NSRWA) and MADEP were reviewed and are summarized by segment below for illustrative purposes.

¹ Class A: Fecal coliform bacteria shall not exceed an arithmetic mean of 20 organisms per 100 mL in any representative set of samples, nor shall 10% of the samples exceed 100 organisms per 100 mL.

Class SA (Shellfishing approved): Fecal coliform bacteria shall not exceed an arithmetic mean of 14 organisms per 100 mL in any representative set of samples, nor shall 10% of the samples exceed 43 organisms per 100 mL.

Class SB (Shellfishing approved): Fecal coliform bacteria shall not exceed an arithmetic mean of 88 organisms per 100 mL in any representative set of samples, nor shall 10% of the samples exceed 260 organisms per 100 mL.

Class B, Class SA & Class SB (waters not designated for shellfishing): Fecal coliform bacteria shall not exceed a geometric mean of 200 organisms per 100 mL in any representative set of samples, nor shall 10% of the samples exceed 400 organisms per 100 mL. The MADEP may apply these standards on a seasonal basis.

² Freshwater bathing beaches: No single *E. coli* sample shall exceed 235 colonies per 100 mL and the geometric mean of the most recent five *E. coli* samples within the same bathing season shall not exceed 126 colonies per 100 mL; or No single enterococci sample shall exceed 61 colonies per 100 mL and the geometric mean of the most recent five (5) enterococci samples within the same bathing season shall not exceed 33 colonies per 100 mL.

Marine bathing beaches: No single enterococci sample shall exceed 104 colonies per 100 mL and the geometric mean of the most recent five enterococci levels within the same bathing season shall not exceed 35 colonies per 100 mL.

³ BEACH Act - Marine bathing beaches: No single enterococci sample shall exceed 104 colonies per 100 mL and the geometric mean of the most recent five enterococci levels within the same bathing season shall not exceed 35 colonies per 100 mL.

Table 4-3. South Coastal Watershed Pathogen Impaired Segments Requiring TMDLs
(adapted from MassGIS 2005 and MADEP 2005a).

Segment ID	Segment Name	Segment Type	Size ¹	Segment Description
MA94-01	Cohasset Harbor	Estuary	0.70	South of a line drawn from the northwest point of Scituate Neck, Scituate to just north of Quarry Point, Cohasset – not including Cohasset Cove
MA94-02	Scituate Harbor	Estuary	0.32	West of line drawn across the mouth of Scituate Harbor, from the elbow of the jetty southeast off Lighthouse Point to the jetty northeast of the US Coast Guard station, Scituate
MA94-03	French Stream	River	6.1	Headwaters on southeast side of Naval Air Station, Rockland through Studleys Pond to confluence with Drinkwater River, Hanover. Miles 5.9-0.0
MA94-05	North River	Estuary	0.3	Confluence of Indian Head River and Herring Brook, Hanover/Pembroke to Route 3A (Main Street), Marshfield/Scituate.
MA94-07	Herring River	Estuary	0.08	Outlet Old Oaken Bucket Pond to confluence with North River.
MA94-09	South River	Estuary	0.63	Main Street, Marshfield to confluence with North River.
MA94-06	North River	Estuary	0.56	Route 3A (Main Street), Marshfield/Scituate to mouth at Massachusetts Bay, Scituate.
MA94-11	Green Harbor	Estuary	0.08	From the tide gates at Rte 139, Marshfield to the mouth of the harbor at MA Bay/Cape Cod Bay, Marshfield
MA94-14	Jones River	Estuary	0.09	Elm Street, Kingston to mouth at Duxbury Bay, Kingston.
MA94-15	Duxbury Bay	Estuary	12.7	North and west of a line drawn from Saquish Head to the tip of Plymouth Beach to High Cliff, Plymouth – excluding Back River and Bluefish River, Duxbury and Jones River, Kingston
MA94-16	Plymouth Harbor	Estuary	2.53	South of a line drawn from the tip of Plymouth Beach to High Cliff, Plymouth
MA94-17	Plymouth Bay	Estuary	10.3	Southeast of a line drawn from Saquish Head to the tip of Plymouth Beach and west of a line drawn from Gurnet Point to Rocky Point, Plymouth

¹ Units = Miles for river segments and square miles for estuaries

This TMDL was based on the current WQS using fecal coliform as an indicator organism for fresh and marine waters and enterococci for marine beaches. The MADEP is in the process of developing new WQS incorporating *E. coli* and enterococci as indicator organisms for all waters other than shellfishing and potable water intake areas. Data from several sources were used for this evaluation including, but not limited to, MADEP, Massachusetts Division of Marine Fisheries (DMF), individual Town beach data and the North and South River Watershed Association (NSRWA) data. Not all data presented herein were used to determine impairment listing due to a variety of reasons (including a requirement for proper data quality assurance and quality control). As such, the MADEP used only a subset of the available data to generate the 2002 List. Other data presented in this section are for illustrative purposes only and generally collaborate MADEP findings. A pathogen TMDL has been completed for Little Harbor (MA94-20) in Cohasset. The Little Harbor TMDL is available online at <http://www.mass.gov/dep/brp/wm/tmdls.htm>.

Data from the Massachusetts Division of Marine Fisheries (DMF) were used, in part, as the basis for pathogen impairment for many of the estuarine areas (Figure 1-1). Numerous samples have been collected throughout the South Coastal watershed by the DMF. DMF has a well-established and effective shellfish monitoring program that provides quality assured data for each shellfish growing area. In addition, each growing area must have a complete sanitary survey every 12 years, a triennial evaluation every three years and an annual review in order to maintain a shellfishing harvesting classification with the exception of those areas already classified as Prohibited. The National Shellfish Sanitation Program establishes minimum requirements for sanitary surveys, triennial evaluations, annual reviews and annual fecal coliform water quality monitoring and includes identification of specific sources and assessment of effectiveness of controls and attainment of standards. "Each year water samples are collected by the DMF at 2,320 stations in 294 growing areas in Massachusetts's coastal waters at a minimum frequency of five times while open to harvesting." (DMF 2002) Due to the volume of data collected by the DMF, these data are not provided herein. For the most recent indicator bacteria sampling data, please contact your local city or town shellfish constable or DMF's Shellfish Project.

The North and South Rivers Watershed Association

Data summarized in the following subsections can be found at:

- **NSRWA River Watch. 2003-2004.** The North and South Rivers Watershed Association. Available for download at http://www.nsrwa.org/programs/river_watch_monitoring.asp. Additional data for 1999-2002 are also available on the website.

Sampling results for each year are presented in separate tables. Results are presented by location and date. Sample results exceeding the threshold for the Massachusetts threshold for swimming are presented in bold. The rainfall for the last 48 hours before the sampling is also indicated in each table in the last column.

The MADPH publishes annual reports on the testing of public and semi-public beaches for both marine and fresh waters. These documents provide water quality data for each bathing beach by community and note if there were exceedances of water quality criteria. There is also a list of communities that did not report testing results. These reports can be downloaded from <http://www.mass.gov/dph/beha/tox/reports/beach/beaches.htm>. Please see the MADPH annual beach report for specific details regarding swimming beaches.

At this time, the MADEP Water Quality Assessment Report has not been completed for the South Coastal watershed. Therefore, information regarding water withdrawals, NPDES discharges and recent indicator bacteria data were not readily available for this TMDL. Data collected by the MADEP as part of the DWM Year 2001 Water Quality Monitoring Data Technical Memorandum TM-94-1 (MADEP 2005b) are provided along with data collected by the NSRWA data in the following section.

Cohasset Harbor Segment MA94-01

This segment is a 0.7 square mile Class SA waterbody. This segment includes waters south of a line drawn from the northwestern point of Scituate Neck, Scituate to just north of Quarry Point, Cohasset not including Cohasset Cove, Cohasset/Scituate.

DMF Shellfish Growing Area Status as of July 2000: Portions of this segment are Approved and Prohibited (Figure 1-1).

Scituate Harbor Segment MA94-02

This segment is a 0.32 square mile Class SA waterbody. This segment includes waters west of a line across the mouth of Scituate Harbor, from the elbow of the jetty southeast off Lighthouse Point to the jetty northeast of the U.S. Coast Guard station, Scituate.

DMF Shellfish Growing Area Status as of July 2000: Prohibited (Figure 1-1).

French Stream Segment MA94-03

This segment is a 6.1 mile Class B warm water fishery extending from the headwaters on the southeast side of the Weymouth Naval Air Station in Rockland to the confluence with Drinkingwater River in Hanover. This segment includes Studleys Pond.

Three locations were sampled along the French River by the MADEP in 2001. A summary of these data are provided in Table 4-4.

Table 4-4. MA94-03 French Stream 2001 Indicator Bacteria Data Summary

Station	Range of Fecal Coliform (Number of Samples)	Range of <i>E. coli</i> (Number of Samples)	Range of Enterococcus (Number of Samples)
FS103 – North Avenue crossing, Rockland	83 – 2000 (4)	88 – 365 (4)	420 – 1750 (3)
FS102 – Summer Street crossing, Rockland	200 – 920 (4)	180 – 560 (4)	460 – 9000 (3)
FS101 – 300 feet downstream of unnamed tributary (Rockland WWTP discharge canal)	110 – 850 (4)	90 – 440 (4)	1800 – 14000 (3)

Units = colony forming units per 100 mL (cfu/100 mL)

Duplicate samples have been averaged and reported as a single sample

North River Segment MA94-05

This segment is a 0.3 square mile Class SA Outstanding Resource Water. The segment begins at the confluence of Indian Head River and Herring Brook, Hanover/Pembroke and extends to Route 3A (Main Street), Marshfield/Scituate.

DMF Shellfish Growing Area Status as of July 2000: Prohibited (Figure 1-1).

Two locations were sampled along this portion of the North River by the MADEP in 2001. A summary of these data are provided in Table 4-5. Additional data for this segment, collected by the NSRWA, are provided immediately following the South River Segment MA94-09 discussion. Data specific for the North River Segment MA94-05 are provided in columns titled “Corn Hill Lane” and “Union Street Bridge” in Tables 4-7 and 4-8.

Table 4-5. MA94-05 North River 2001 Indicator Bacteria Data Summary

Station	Range of Fecal Coliform (Number of Samples)	Range of <i>E. coli</i> (Number of Samples)	Range of Enterococcus (Number of Samples)
NR103 – Rte 53/139 bridge, Hanover/Pembroke	62 – 790 (4)	70 – 450 (4)	170 – 1000 (3)
NR102 – Bridge Street/Union Street bridge, Norwell/Marshfield	14 – 100 (4)	<5 – 30 (4)	15 – 210 (3)

Units = colony forming units per 100 mL (cfu/100 mL)

North River Segment MA94-06

This segment is a 0.56 square mile Class SA waterbody. The segment extends from Route 3A (Main Street), Marshfield/Scituate to the confluence with the South River, Scituate.

DMF Shellfish Growing Area Status as of July 2000: Portions of this segment are Approved and Conditionally Approved (Figure 1-1).

One location was sampled along this section of the North River by the MADEP in 2001. The four fecal coliform samples ranged from 23 to 40 cfu/100mL. The four *E. coli* samples ranged from <5 to 13 cfu/100mL. Three enterococci samples ranged from <5 to 43 cfu/100mL. Samples and duplicates were averaged for summation purposes. Additional data for this segment, collected by the NSRWA, are provided immediately following the South River Segment MA94-09 discussion. Data specific for the North River Segment MA94-06 are provided in columns titled “North River Marina” and “Damon’s Point” in Tables 4-7 and 4-8.

Herring River Segment MA94-07

This segment is a 0.08 square mile Class SA waterbody. The segment extends the outlet of Old Oaken Bucket Pond to the confluence with North River in Scituate.

DMF Shellfish Growing Area Status as of July 2000: Prohibited (Figure 1-1).

The NSRWA collected indicator bacteria samples at one location (James Landing Marina) along this segment. Data are provided in Tables 4-7 and 4-8 following the South River Segment MA94-09 discussion.

South River Segment MA94-09

This segment is a 0.63 square mile Class SA Outstanding Resource Water. The segment begins at the dam at Main Street in Marshfield to the confluence with North River in Marshfield/Scituate.

DMF Shellfish Growing Area Status as of July 2000: Prohibited (Figure 1-1).

Two locations were sampled along this portion of the South River by the MADEP in 2001. A summary of these data are provided in Table 4-6. Additional data for this segment collected by the NSRWA are provided in columns titled “Willow Street Bridge” and “Julian Street Bridge” in Tables 4-7 and 4-8.

Table 4-6. MA94-09 South River 2001 Indicator Bacteria Data Summary

Station	Range of Fecal Coliform (Number of Samples)	Range of <i>E. coli</i> (Number of Samples)	Range of Enterococcus (Number of Samples)
SR102 – Route 3A (Main St.) bridge, Marshfield	29 – 140 (4)	38 – 71 (4)	150 – 460 (3)
SR101 – Julian Street/Bayberry Road Bridge, Scituate/Marshfield	15 – 170 (4)	<5 – 20 (4)	25 – 360 (3)

Units = colony forming units per 100 mL (cfu/100 mL)

The North and South Rivers Watershed Association (NSRWA) River Watch conducted water quality sampling on the North River, South River and tributaries between 1999 and 2004. Sampling locations are provided in Figure 4-1. Results for the 2003 and 2004 sampling are summarized in Tables 4-7 and 4-8.

Figure 4-1. NSRWA River Watch Fecal Coliform Sampling Stations (from NSRWA 2004).

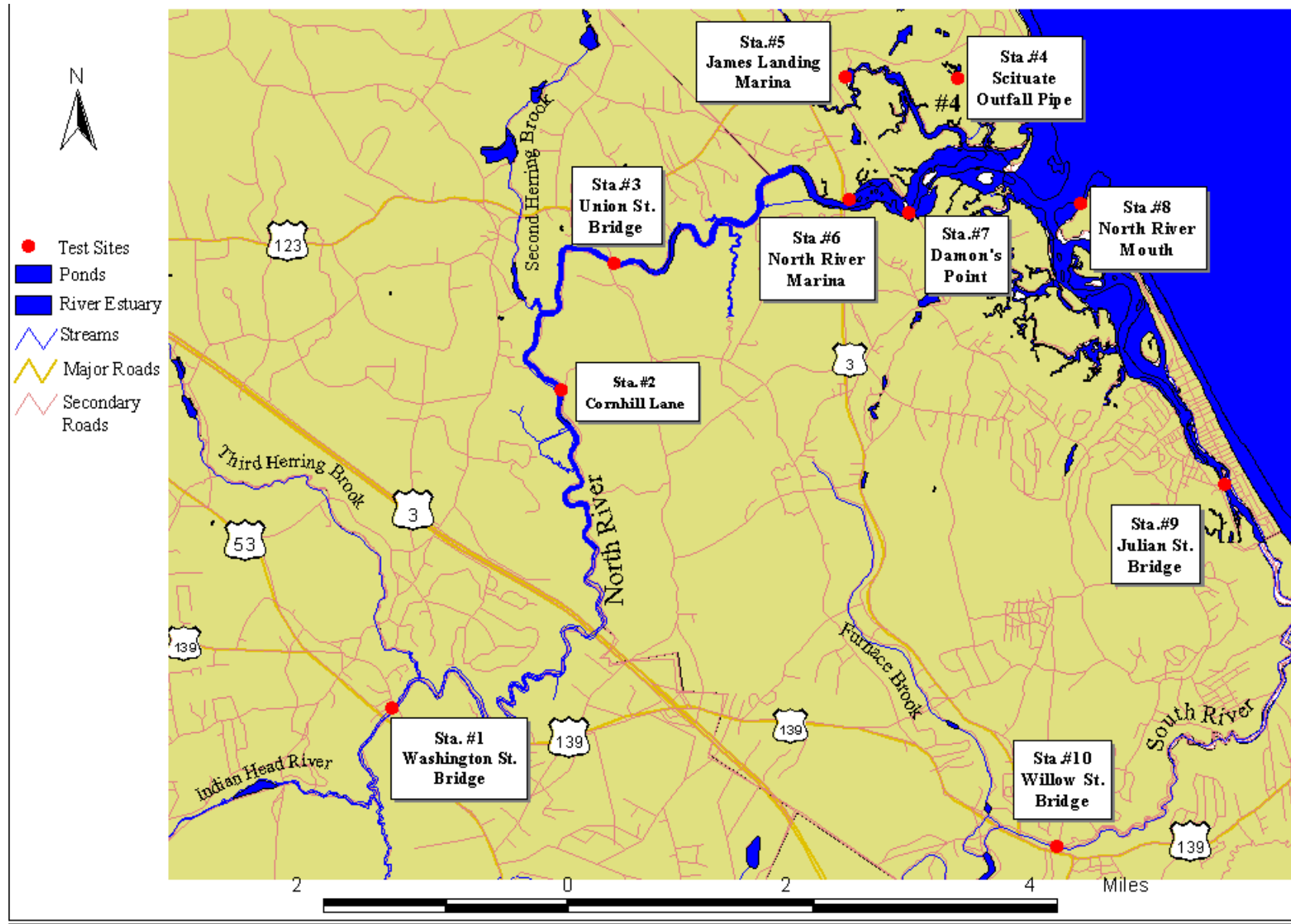


Table 4-7. NSRWA River Watch Fecal Coliform Data for 2004 (from NSRWA 2004).

Date	North River and Tributaries								South River		Rainfall in last 48 hours
	Washington Street Bridge	Corn Hill Lane	Union Street Bridge	Scituate Outfall Pipe	James Landing Marina	North River Marine	Damon's Point	North River Mouth	Julian Street Bridge	Willow Street Bridge	
6/10	130	73	60	2	220	15	19	3	200	220	0
6/24	300	91	52	1	81	27	4	2	90	300	0
6/28	290	160	98	5	91	73	47	1	800	400	0
7/8	180	40	37	12	35	27	9	2	100	400	0
7/21	240	180	71	2	51	67	57	9	700	210	0
7/26	240	77	42	66	43	12	9	0	80	83	0
8/9	72	120	29	7	1	7	5	0	24	190	0
8/24	110	500	360	2	32	74	53	0	190	220	0
9/8	1100	300	65	32	190	96	47	15	3100	7900	1.05-2.0+
Numbers indicate colonies of fecal coliform bacteria per 100 mL of water Numbers in boldface exceed Massachusetts thresh hold for swimming (200+ per 100mL) Massachusetts threshold for shellfish is 14+ per 100mL and for drinking water is 0 per 100mL											

Table 4-8. NSRWA River Watch Fecal Coliform Data for 2003 (taken from NSRWA 2004).

Date	North River and Tributaries								South River		Rainfall in last 48 hours
	Washington Street Bridge	Corn Hill Lane	Union Street Bridge	Scituate Outfall Pipe	James Landing Marina	North River Marine	Damon's Point	North River Mouth	Julian Street Bridge	Willow Street Bridge	
6/10	64	110	100	0	91	48	14	2	96	28	0
6/25	300	340	340	0	80	260	110	23	330	140	1.64
7/7	400	120	77	0	59	44	20	2	170	180	0
7/10	130	290	130	1	80	11	12	0	200	220	0
7/21	100	58	29	2	24	15	12	2	26	220	0
8/6	180	400	210	0	110	100	78	36	300	100	0.48
8/19	110	240	76	0	19	30	25	24	400	200	0.12
9/3	800	220	75	0	40	41	28	11	120	600	0.13
Numbers indicate colonies of fecal coliform bacteria per 100 mL of water Numbers in boldface exceed Massachusetts thresh hold for swimming (200+ per 100mL) Massachusetts threshold for shellfish is 14+ per 100mL and for drinking water is 0 per 100mL											

Green Harbor Segment MA94-11

This segment is a 0.08 square mile Class SA waterbody. The segment begins at the tide gates at Route 139 in Marshfield and extends to the mouth of the harbor.

DMF Shellfish Growing Area Status as of July 2000: Approved (Figure 1-1).

Jones River Segment MA94-14

This segment is a 0.09 square mile Class SA waterbody. The segment begins at the dam at Elm Street and extends to the mouth at Duxbury Bay in Kingston.

DMF Shellfish Growing Area Status as of July 2000: Prohibited (Figure 1-1).

Two locations were sampled along this portion of the Jones River by the MADEP in 2001. A summary of these data are provided in Table 4-9.

Table 4-9. MA94-14 Jones River 2001 Indicator Bacteria Data Summary

Station	Range of Fecal Coliform (Number of Samples)	Range of <i>E. coli</i> (Number of Samples)	Range of Enterococcus (Number of Samples)
JR102 – Impoundment upstream of Elm St bridge, Kingston	27 – 180 (4)	17 – 85 (4)	15 – 81 (3)
JR101 – Route 3A (Main St.) crossing, Kingston	80 – 250 (4)	27 – 100 (4)	330 – 1000 (3)

Units = colony forming units per 100 mL (cfu/100 mL)

Duxbury Bay Segment MA94-15

This segment is a 12.7 square mile Class SA waterbody. The segment includes waters north and west of a line from Saquish Head to the tip of Plymouth Beach and to High Cliff in Plymouth excluding Back River and Bluefish River in Duxbury and Jones River in Kingston.

DMF Shellfish Growing Area Status as of July 2000: Portions of this segment are Approved, Conditionally Approved and Prohibited (Figure 1-1).

Plymouth Harbor Segment MA94-16

This segment is a 2.53 square mile Class SA waterbody. The segment includes waters south of a line drawn from the tip of Plymouth Beach to High Cliff in Plymouth.

DMF Shellfish Growing Area Status as of July 2000: Prohibited (Figure 1-1).

Plymouth Bay Segment MA94-17

This segment is a 10.3 square mile Class SA waterbody. The segment includes waters southeast of a line drawn from Saquish Head to the tip of Plymouth Beach and west of a line from Gurnet Point to Rocky Point in Plymouth.

DMF Shellfish Growing Area Status as of July 2000: Approved (Figure 1-1).

5.0 Potential Sources

The South Coastal watershed has 12 segments, located throughout the watershed, that are listed as pathogen impaired requiring TMDLs. These segments represent 99.0% of the estuary area and 18.2% of the river miles assessed. Sources of indicator bacteria in the South Coastal watershed are many and varied.

Some dry weather sources may include:

- animal feeding operations,
- animal grazing in riparian zones,
- leaking sewer pipes,
- storm water drainage systems (illicit connections of sanitary sewers to storm drains),
- failing septic systems,
- wildlife, including birds,
- recreational activities, and
- illicit boat discharges.

Some wet weather sources may include:

- wildlife and domesticated animals (including pets),
- storm water runoff including municipal separate storm sewer systems (MS4),
- combined sewer overflows (CSOs), and
- sanitary sewer overflows (SSOs).

It is difficult to provide accurate quantitative estimates of indicator bacteria contributions from the various sources in the South Coastal watershed, because many of the sources are diffuse and intermittent, and extremely difficult to monitor or accurately model. Therefore, a general level of quantification according to source category is provided (e.g., see Tables 5-1 and 5-2). This approach is suitable for the TMDL analysis, because it indicates the magnitude of the sources and illustrates the need for controlling them. Additionally, many of the sources (failing septic systems, leaking sewer pipes, sanitary sewer overflows, and illicit sanitary sewer connections) are prohibited, because they indicate a potential health risk and, therefore, must be eliminated. However, estimating the magnitude of overall indicator bacteria loading (the sum of all contributing sources) is achieved for wet and dry conditions using the ambient data available that define baseline conditions (see Tables 4-4 through 4-9).

Agriculture

Land used primarily for agriculture is likely to be impacted by a number of activities that can contribute to indicator bacteria impairments of surface waters. Activities with the potential to contribute to high indicator bacteria concentrations include:

- Field application of manure,
- Runoff from grazing areas,
- Direct deposition from livestock in streams,
- Animal feeding operations,

- Leaking manure storage facilities, and
- Runoff from barnyards.

Indicator bacteria numbers are generally associated with sediment loading. Reducing sediment loading often results in a reduction of indicator bacteria loading as well. Brief summaries of some of these techniques are provided in the “*Mitigation Measures to Address Pathogen Pollution in Surface Water: A TMDL Implementation Guidance Manual for Massachusetts*”.

Sanitary Waste

Leaking sewer pipes, illicit sewer connections, sanitary sewer overflows (SSOs), combined sewer overflows (CSOs) and failing septic systems represent a direct threat to public health since they result in discharge of partially treated or untreated human wastes to the surrounding environment. Quantifying these sources is extremely speculative without direct monitoring of the source, because the magnitude is directly proportional to the volume of the source and its proximity to the surface water. Typical values of fecal coliform in untreated domestic wastewater range from 10^4 to 10^6 MPN/100mL (Metcalf and Eddy 1991).

Illicit sewer connections into storm drains result in direct discharges of sewage via the storm drainage system outfalls. The existence of illicit sewer connections to storm drains is well documented in many urban drainage systems, particularly older systems that may have once been combined. It is probable that numerous illicit sewer connections exist in storm drainage systems serving the older developed portions of the basin.

Monitoring of storm drain outfalls during dry weather is needed to document the presence or absence of sewage in the drainage systems. Approximately 70.3 percent of the South Coastal watershed is classified as Urban Areas by the United States Census Bureau and is therefore subject to the Stormwater Phase II Final Rule that requires the development and implementation of an illicit discharge detection and elimination plan. See Section 7.0 of this TMDL for information regarding illicit discharge detection guidance.

Septic systems designed, installed, operated and maintained in accordance with 310 CMR 15.000: Title 5, are not significant sources of fecal coliform bacteria. Studies demonstrate that wastewater located four feet below properly functioning septic systems contain on average less than one fecal coliform bacteria organism per 100 mL (Ayres Associates 1993). Failed or non-conforming septic systems, however, can be a major contributor of fecal coliform to the South Coastal watershed. Wastes from failing septic systems enter surface waters either as direct overland flow or via groundwater. Wet weather events typically increase the rate of transport of pollutant loadings from failing septic systems to surface waters because of the wash-off effect from runoff and the increased rate of groundwater recharge.

Recreational use of waterbodies is a source of pathogen contamination. Swimmers themselves may contribute to bacterial impairment at swimming areas. When swimmers enter the water, residual fecal matter may be washed from the body and contaminate the water with pathogens. In addition,

small children in diapers may contribute to contamination of the recreational waters. These sources are likely to be particularly important when the number of swimmers is high and the flushing action of waves or tides is low.

Another potential source of pathogens is the discharge of sewage from vessels with onboard toilets. These vessels are required to have a marine sanitation device (MSD) to either store or treat sewage. When MSDs are operated or maintained incorrectly they have the potential to discharge untreated or inadequately treated sewage. For example, some MSDs are simply tanks designed to hold sewage until it can be pumped out at a shore-based pump-out facility or discharged into the water more than three miles from shore. Uneducated boaters may discharge untreated sewage from these devices into near-shore waters. In addition, when MSDs designed to treat sewage are improperly maintained or operated they may malfunction and discharge inadequately treated sewage. Finally, even properly operating MSDs may discharge sewage in concentrations higher than allowed in ambient water for fishing or shellfishing. Vessels are most likely to contribute to bacterial impairment in situations where large numbers of vessels congregate in enclosed environments with low tidal flushing. Many marinas and popular anchorages are located in such environments.

Wildlife and Pet Waste

Animals that are not pets can be a potential source of pathogens. Geese, gulls, and ducks are speculated to be a major pathogen source, particularly at lakes and storm water ponds where large resident populations have become established (Center for Watershed Protection 1999).

Household pets such as cats and dogs can be a substantial source of bacteria – as much as 23,000,000 colonies/gram, according to the Center for Watershed Protection (1999). A rule of thumb estimate for the number of dogs is ~1 dog per 10 people producing an estimated 0.5 pound of feces per dog per day. Uncollected pet waste is then flushed from the parks, beaches and yards where pets are walked and transported into nearby waterways during wet-weather.

Storm Water

Storm water runoff is another significant contributor of pathogen pollution. As discussed above, during rain events fecal matter from domestic animals and wildlife are readily transported to surface waters via the storm water drainage systems and/or overland flow. The natural filtering capacity provided by vegetative cover and soils is dramatically reduced as urbanization occurs because of the increase in impervious areas (i.e., streets, parking lots, etc.) and stream channelization in the watershed.

Extensive storm water data have been collected and compiled both locally and nationally (e.g., Tables 4-1, 4-2, 5-1 and 5-2) in an attempt to characterize the quality of storm water. Bacteria are easily the most variable of storm water pollutants, with concentrations often varying by factors of 10 to 100 during a single storm. Considering this variability, storm water bacteria concentrations are difficult to accurately predict. Caution must be exercised when using values from single wet weather grab samples to estimate the magnitude of bacteria loading, because it is often unknown whether the sample is representative of the “true” mean. To gain an understanding of the magnitude of bacterial loading from storm water and avoid overestimating or underestimating bacteria loading, event mean concentrations (EMC) are often used. An EMC is the concentration of a flow

proportioned sample throughout a storm event. These samples are commonly collected using an automated sampler which can proportion sample aliquots based on flow. Typical storm water event mean densities for various indicator bacteria in Massachusetts watersheds and nationwide are provided in Tables 5-1 and 5-2. These EMCs illustrate that storm water indicator bacteria concentrations from certain land uses (i.e., residential) are typically at levels sufficient to cause water quality problems.

Table 5-1. Lower Charles River Basin Storm Water Event Mean Bacteria Concentrations (data summarized from USGS 2002) and Necessary Reductions to Meet Class B WQS.

Land Use Category	Fecal Coliform EMC (CFU/100 mL)	Number of Events	Class B WQS ¹	Reduction to Meet WQS (%)
Single Family Residential	2,800 – 94,000	8	10% of the samples shall not exceed 400 organisms/ 100 mL	2,400 – 93,600 (85.7 – 99.6)
Multifamily Residential	2,200 – 31,000	8		1,800 – 30,600 (81.8 – 98.8)
Commercial	680 – 28,000	8		280 – 27,600 (41.2 - 98.6)

¹ Class B Standard: Shall not exceed a geometric mean of 200 organisms in any set of representative samples, nor shall 10% of the samples exceed 400 organisms. Used 400 to illustrate required reductions since a geometric mean of the samples were not provided.

Table 5-2. Storm Water Event Mean Fecal Coliform Concentrations (as reported in MADEP 2002b; original data provided in Metcalf & Eddy, 1992) and Necessary Reductions to Meet Class B WQS.

Land Use Category	Fecal Coliform ¹ Organisms / 100 mL	Class B WQS ²	Reduction to Meet WQS (%)
Single Family Residential	37,000	10% of the samples shall not exceed 400 organisms/ 100 mL	36,600 (98.9)
Multifamily Residential	17,000		16,600 (97.6)
Commercial	16,000		15,600 (97.5)
Industrial	14,000		13,600 (97.1)

¹ Derived from NURP study event mean concentrations and nationwide pollutant buildup data (USEPA 1983).

² Class B Standard: Shall not exceed a geometric mean of 200 organisms in any set of representative samples, nor shall 10% of the samples exceed 400 organisms. Used 400 to illustrate required reductions since a geometric mean of the samples were not provided.

6.0 Pathogen TMDL Development

Section 303 (d) of the Federal Clean Water Act (CWA) requires states to place water bodies that do not meet the water quality standards on a list of impaired waterbodies. The most recent impairment list, *2002 List*, identifies 12 segments within the South Coastal watershed for use impairment caused by excessive indicator bacteria concentrations.

The CWA requires each state to establish Total Maximum Daily Loads (TMDLs) for listed waters and the pollutant contributing to the impairment(s). TMDLs determine the amount of a pollutant that a waterbody can safely assimilate without violating the water quality standards. Both point and non-point pollution sources are accounted for in a TMDL analysis. Point sources of pollution (those discharges from discrete pipes or conveyances) subject to NPDES permits receive a waste load allocation (WLA) specifying the amount of pollutant each point source can release to the waterbody. Non-point sources of pollution (all sources of pollution other than point) receive a load allocation (LA) specifying the amount of a pollutant that can be released to the waterbody by this source. In accordance with the CWA, a TMDL must account for seasonal variations and a margin of safety, which accounts for any lack of knowledge concerning the relationship between effluent limitations and water quality. Thus:

$$\text{TMDL} = \text{WLAs} + \text{LAs} + \text{Margin of Safety}$$

Where:

WLA = Waste Load Allocation which is the portion of the receiving water's loading capacity that is allocated to each existing and future point source of pollution.

LA = Load Allocation which is the portion of the receiving water's loading capacity that is allocated to each existing and future non-point source of pollution.

This TMDL uses an alternative standards-based approach which is based on indicator bacteria concentrations, but considers the terms of the above equation. This approach is more in line with the way bacterial pollution is regulated (i.e., according to concentration standards) and achieves essentially the same result as if the equation were to be used.

6.1. Indicator Bacteria TMDL

Loading Capacity

The pollutant loading that a waterbody can safely assimilate is expressed as either mass-per-time, toxicity or some other appropriate measure (40 CFR § 130.2). Typically, TMDLs are expressed as total maximum daily loads. Expressing the TMDL in terms of daily loads is difficult to interpret given the very high numbers of indicator bacteria and the magnitude of the allowable load is dependent on flow conditions and, therefore, will vary as flow rates change. For example, a very high load of indicator bacteria are allowable if the volume of water that transports indicator bacteria is also high. Conversely, a relatively low load of indicator bacteria may exceed water quality standard if flow rates are low. Therefore, the MADEP believes it is appropriate to express indicator bacteria TMDLs in

terms of a concentration because the water quality standard is also expressed in terms of the concentration of organisms per 100 mL. Since source concentrations may not be directly added due to varying flow conditions, the TMDL equation is modified and reflects a margin of safety in the case of this pathogen concentration based TMDL. To ensure attainment with Massachusetts' WQS for indicator bacteria, all sources (at their point of discharge to the receiving water) must be equal to or less than the WQS for indicator organisms. For all the above reasons the TMDL is simply set equal to the concentration-based standard and may be expressed as follows:

$$\text{TMDL} = \text{State Standard} = \text{WLA}_{(p1)} = \text{LA}_{(n1)} = \text{WLA}_{(p2)} = \text{etc.}$$

Where:

$\text{WLA}_{(p1)}$ = allowable concentration for point source category (1)

$\text{LA}_{(n1)}$ = allowable concentration for nonpoint source category (1)

$\text{WLA}_{(p2)}$ = allowable concentration for point source category (2) etc.

For Class A surface waters (1) *the arithmetic mean of a representative set of fecal coliform samples shall not exceed 20 organisms per 100 mL*; and (2) *no more than 10% of the samples shall exceed 100 organisms per 100 mL*.

For Class B and Class SB and SA areas not designated for shellfishing (1) *the geometric mean of a representative set of fecal coliform samples shall not exceed 200 organisms per 100 mL*; and (2) *no more than 10% of the samples shall exceed 400 organisms per 100 mL*.

For Class SA open shellfish area surface waters (1) *the geometric mean of a representative set of fecal coliform samples shall not exceed 14 organisms per 100 mL*; and (2) *no more than 10% of the samples shall exceed 43 organisms per 100 mL*.

For Class SB open shellfish surface waters (1) *the geometric mean of a representative set of fecal coliform samples shall not exceed 88 organisms per 100 mL*; and (2) *no more than 10% of the samples shall exceed 260 organisms per 100 mL*.

For marine bathing beaches (BEACH Act standard) (1) *the geometric mean of a statistically sufficient number of samples (generally not less than 5 samples equally spaced over a 30-day period) shall not exceed 35 colonies per 100 mL* and (2) *no single enterococci sample shall exceed 104 colonies per 100 mL*.

For freshwater bathing beaches (MADPH standard, not yet adopted by the MADEP) (1) *the geometric mean of the most recent five enterococci levels within the same bathing season shall not exceed 33 colonies per 100 mL* and (2) *no single enterococci sample shall exceed 61 colonies per 100 mL*. – OR – (1) *the geometric mean of the most recent five E. coli levels within the same bathing season shall not exceed 126 colonies per 100 mL* and (2) *no single E. coli sample shall exceed 235 colonies per 100 mL*.

Waste Load Allocations (WLAs) and Load Allocations (LAs).

There are WWTPs and other NPDES-permitted wastewater discharges within the South Coastal watershed. NPDES wastewater discharge WLAs are set at the WQS. In addition, there are numerous storm water discharges from storm drainage systems throughout the watershed. All piped discharges are, by definition, point sources regardless of whether they are currently subject to the requirements of NPDES permits. Therefore, a WLA set equal to the WQS will be assigned to the portion of the storm water that discharges to surface waters via storm drains.

WLAs and LAs are identified for all known source categories including both dry and wet weather sources for Class SA, Class SB, Class A and Class B segments within the South Coastal watershed. Establishing WLAs and LAs that only address dry weather indicator bacteria sources would not ensure attainment of standards because of the significant contribution of wet weather indicator bacteria sources to WQS exceedances. Illicit sewer connections and deteriorating sewers leaking to storm drainage systems represent the primary dry weather point sources of indicator bacteria, while failing septic systems and possibly leaking sewer lines represent the non-point sources. Wet weather point sources include discharges from storm water drainage systems (including MS4s), sanitary sewer overflows (SSOs) and combined sewer overflows (CSOs). Wet weather non-point sources primarily include diffuse storm water runoff.

Table 6-1 presents the indicator bacteria WLAs and LAs for the various source categories. WLAs and LAs will change to reflect the revised indicator organisms (*E. coli* and enterococci) when the updated WQS have been finalized (See Section 3.0 of this report). Source categories representing discharges of untreated sanitary sewage to receiving waters are prohibited, and therefore, assigned WLAs and LAs equal to zero. There are several sets of WLAs and LAs, one for Class SA shellfish open waters, one for Class SB shellfish open waters, one for Class A waters, one for Class B and shellfish restricted Class SA and SB waters, one for no discharge areas, one for freshwater beaches, and one for marine beaches.

The TMDL should provide a discussion of the magnitudes of the pollutant reductions needed to attain the goals of the TMDL. Since accurate estimates of existing sources are generally unavailable, it is difficult to estimate the pollutant reductions for specific sources. For the illicit sources including failing septic systems, the goal is complete elimination (100% reduction). However, overall wet weather indicator bacteria load reductions can be estimated using typical storm water bacteria concentrations, as presented in this TMDL. These data indicate that up to two to three orders of magnitude (i.e., greater than 90%) reductions in storm water fecal coliform loadings generally will be necessary especially in developed areas. This goal is expected to be accomplished through implementation of the best management practices (BMPs) associated with the Phase II control program in designated Urban Areas. The specific goal for controlling discharges from CSOs will be based on the site specific studies embodied in the Long Term Control Plan being developed by each community with combined sewers.

Table 6-1. Indicator Bacteria Waste Load Allocations (WLAs) and Load Allocations (LAs) for the South Coastal Watershed.

Surface Water Classification	Pathogen Source	Waste Load Allocation Indicator Bacteria (CFU/100 mL)¹	Load Allocation Indicator Bacteria (CFU/100 mL)¹
A, B, SA, SB	<ul style="list-style-type: none"> Illicit discharges to storm drains Leaking sanitary sewer lines 	0	N/A
A, B, SA, SB	Failing septic systems	N/A	0
A	<ul style="list-style-type: none"> NPDES Storm water runoff Phase I and II 	Not to exceed an arithmetic mean of 20 organisms in any set of representative samples nor shall 10% of the samples exceed 100 organisms ²	N/A
A	Direct storm water runoff not regulated by NPDES and livestock, wildlife & pets	N/A	Not to exceed an arithmetic mean of 20 organisms in any set of representative samples nor shall 10% of the samples exceed 100 organisms ³
B & SA & SB Not Designated for Shellfishing	<ul style="list-style-type: none"> CSOs NPDES – WWTP Storm water runoff Phase I and II 	Shall not exceed a geometric mean of 200 organisms in any set of representative samples, nor shall 10% of the samples exceed 400 organisms ⁴	N/A
B & SA & SB Not Designated for Shellfishing	Direct storm water runoff not regulated by NPDES and livestock, wildlife & pets	N/A	Not to exceed a geometric mean of 200 organisms in any set of representative samples, nor shall 10% of the samples exceed 400 organisms ³
SA Designated Shellfishing Areas	<ul style="list-style-type: none"> NPDES – WWTP Storm water Runoff Phase I and II 	Not to exceed a geometric mean of 14 organisms in any set of representative samples, nor shall 10% of the samples exceed 43 organisms ²	N/A
SA Designated Shellfishing Areas	Direct storm water runoff not regulated by NPDES and livestock, wildlife & pets	N/A	Not to exceed a geometric mean of 14 organisms in any set of representative samples, nor shall 10% of the samples exceed 43 organisms ³
SB Designated Shellfishing Areas	<ul style="list-style-type: none"> CSOs NPDES – WWTP Storm water runoff Phase I and II 	Not to exceed a geometric mean of 88 organisms in any set of representative samples, nor shall 10% of the samples exceed 260 organisms ⁴	N/A
SB Designated Shellfishing Areas	Direct storm water runoff not regulated by NPDES and livestock, wildlife & pets	N/A	Not to exceed a geometric mean of 88 organisms in any set of representative samples, nor shall 10% of the samples exceed 260 organisms ³

Table 6-1 (continued). Indicator Bacteria Waste Load Allocations (WLAs) and Load Allocations (LAs) for the South Coastal Watershed.

Surface Water Classification	Pathogen Source	Waste Load Allocation Indicator Bacteria (CFU/100 mL)¹	Load Allocation Indicator Bacteria (CFU/100 mL)¹
No Discharge Areas	Vessels – raw or treated sanitary waste	0	N/A
Marine Beaches ⁵	All Sources	Enterococci not to exceed a geometric mean of 35 colonies in a statistically significant number of samples, nor shall any single sample exceed 104 colonies	Enterococci not to exceed a geometric mean of 35 colonies in a statistically significant number of samples, nor shall any single sample exceed 104 colonies
Fresh Water Beaches ⁶	All Sources	Enterococci not to exceed a geometric mean of 33 colonies of the five most recent samples within the same bathing season, nor shall any single sample exceed 61 colonies OR <i>E. coli</i> not to exceed a geometric mean of 126 colonies of the five most recent samples within the same bathing season, nor shall any single sample exceed 235 colonies	Enterococci not to exceed a geometric mean of 33 colonies of the five most recent samples within the same bathing season, nor shall any single sample exceed 61 colonies OR <i>E. coli</i> not to exceed a geometric mean of 126 colonies of the five most recent samples within the same bathing season, nor shall any single sample exceed 235 colonies

N/A means not applicable

¹ Waste Load Allocation (WLA) and Load Allocation (LA) refer to fecal coliform densities unless specified in table.

² Or shall be consistent with the Waste Water Treatment Plant (WWTP) National Pollutant Discharge Elimination System (NPDES) permit.

³The expectation for WLAs and LAs for storm water discharges is that they will be achieved through the implementation of BMPs and other controls.

⁴ Or shall be consistent with an approved Long Term Control Plan (LTCP) for Combined Sewer Overflow (CSO) abatement. If the level of control specified in the LTCP is less than what is necessary to attain Class B water quality standards, then the above criteria apply unless MADEP has proposed and EPA has approved water quality standards revisions for the receiving water.

⁵ Federal Beaches Environmental Assessment and Coastal Health Act of 2000 (BEACH Act) Water Quality Criteria

⁶ Massachusetts Department of Public Health regulations (105 CMR Section 445)

Note: this table represents waste load and load reductions based on water quality standards current as of the publication date of these TMDLs, any future changes made to the Massachusetts water quality standards will become the governing water quality standards for these TMDLs.

The expectation to attain WQS at the point of discharge is environmentally protective, and offers a practical means to identify and evaluate the effectiveness of control measures. In addition, this approach establishes clear objectives that can be easily understood by the public and individuals responsible for monitoring activities.

This TMDL applies to the 12 pathogen impaired segments of the South Coastal watershed that are currently listed on the CWA § 303(d) list of impaired waters (see Figure 1-1, Table 4-3). MADEP recommends however, that the information contained in this TMDL guide management activities for all other waters throughout the watershed to help maintain and protect existing water quality. For these non-impaired waters, Massachusetts is proposing “pollution prevention TMDLs” consistent with CWA § 303(d)(3).

The analyses conducted for the pathogen impaired segments in this TMDL would apply to the non-impaired segments, since the sources and their characteristics are equivalent. The waste load and/or load allocation for each source and designated use would be the same as specified herein. Therefore, the pollution prevention TMDLs would have identical waste load and load allocations based on the sources present and the designated use of the water body segment (see Table ES-1 and Table 6-1).

This South Coastal watershed TMDL may, in appropriate circumstances, also apply to segments that are listed for pathogen impairment in subsequent Massachusetts CWA § 303(d) Integrated List of Waters. For such segments, this TMDL may apply if, after listing the waters for pathogen impairment and taking into account all relevant comments submitted on the CWA § 303(d) list, the Commonwealth determines with EPA approval of the CWA § 303(d) list that this TMDL should apply to future pathogen impaired segments.

6.2. Margin of Safety

This section addresses the incorporation of a Margin of Safety (MOS) in the TMDL analysis. The MOS accounts for any uncertainty or lack of knowledge concerning the relationship between pollutant loading and water quality. The MOS can either be implicit (i.e., incorporated into the TMDL analysis through conservative assumptions) or explicit (i.e., expressed in the TMDL as a portion of the loadings). This TMDL uses an implicit MOS, through inclusion of two conservative assumptions. First, the TMDL does not account for mixing in the receiving waters and assumes that zero dilution is available. Realistically, influent water will mix with the receiving water and become diluted below the water quality standard, provided that the receiving water concentration does not exceed the TMDL concentration. Second, the goal of attaining standards at the point of discharge does not account for losses due to die-off and settling of indicator bacteria that are known to occur.

6.3. Seasonal Variability

In addition to a Margin of Safety, TMDLs must also account for seasonal variability. Pathogen sources to South Coastal watershed waters arise from a mixture of continuous and wet-weather driven sources, and there may be no single critical condition that is protective for all other conditions. This TMDL has set WLAs and LAs for all known and suspected source categories equal to the Massachusetts WQS independent of seasonal and climatic conditions. This will ensure the

attainment of water quality standards regardless of seasonal and climatic conditions. Controls that are necessary will be in place throughout the year, protecting water quality at all times. However, for discharges that do not affect shellfish beds, intakes for water supplies and primary contact recreation is not taking place (i.e., during the winter months) seasonal disinfection is permitted for NPDES point source discharges.

7.0 Implementation Plan

Setting and achieving TMDLs should be an iterative process, with realistic goals over a reasonable timeframe and adjustment as warranted based on ongoing monitoring. The concentrations set out in the TMDL represent reductions that will require substantial time and financial commitment to be attained. A comprehensive control strategy is needed to address the numerous and diverse sources of pathogens in the South Coastal watershed.

Controls on several types of pathogen sources will be required as part of the comprehensive control strategy. Many of the sources in the South Coastal watershed including sewer connections to drainage systems, leaking sewer pipes, sanitary sewer overflows, and failing septic systems, are prohibited and must be eliminated. Individual sources must be first identified in the field before they can be abated. Pinpointing sources typically requires extensive monitoring of the receiving waters and tributary storm water drainage systems during both dry and wet weather conditions. A comprehensive program is needed to ensure illicit sources are identified and that appropriate actions will be taken to eliminate them.

Storm water runoff represents another major source of pathogens in the South Coastal watershed, and the current level of control is inadequate for standards to be attained. Improving storm water runoff quality is essential for restoring water quality and recreational uses. At a minimum, intensive application of non-structural BMPs is needed throughout the watershed to reduce pathogen loadings as well as loadings of other storm water pollutants (e.g., nutrients and sediments) contributing to use impairment in the South Coastal watershed. Depending on the degree of success of the non-structural storm water BMP program, structural controls may become necessary.

For these reasons, a basin-wide implementation strategy is recommended. The strategy includes a mandatory program for implementing storm water BMPs and eliminating illicit sources. The *“Mitigation Measures to Address Pathogen Pollution in Surface Water: A TMDL Implementation Guidance Manual for Massachusetts”* was developed to support implementation of pathogen TMDLs. TMDL implementation-related tasks are shown in Table 7-1. The MADEP working with EPA, NSRWA, Massachusetts Bay Program (MBP), and other team partners shall make every reasonable effort to assure implementation of this TMDL. These stakeholders can provide valuable assistance in defining hot spots and sources of pathogen contamination as well as the implementation of mitigation or preventative measures.

Table 7-1. Tasks

Task	Organization
Writing TMDL	MADEP/EPA
TMDL public meeting	MADEP/EPA
Response to public comment	MADEP
Organization, contacts with volunteer groups	MADEP/NSRWA
Development of comprehensive storm water management programs including identification and implementation of BMPs	South Coastal Watershed Communities, where applicable
Illicit discharge detection and elimination	South Coastal Watershed Communities and NSRWA, where applicable
Leaking sewer pipes and sanitary sewer overflows	South Coastal Watershed Communities, where applicable
CSO management	South Coastal Watershed Communities, where applicable
Inspection and upgrade of on-site sewage disposal systems as needed	Homeowners, South Coastal Watershed Communities (Boards of Health)
Organize implementation; work with stakeholders and local officials to identify remedial measures and potential funding sources	South Coastal Watershed Communities, NSRWA, and MBP
Organize and implement education and outreach program	South Coastal Watershed Communities, NSRWA, and MBP
Write grant and loan funding proposals	MADEP, South Coastal Watershed Communities, NSRWA, and MBP
Inclusion of TMDL recommendations in Executive Office of Environmental Affairs (EOEA) Watershed Action Plan	EOEA
Surface Water Monitoring	MADEP, South Coastal Watershed Communities, and NSRWA
Provide periodic status reports on implementation of remedial activities	MADEP, South Coastal Watershed Communities, NSRWA, and MBP

7.1. Summary of Activities within the South Coastal Watershed

Data supporting this TMDL indicate that indicator bacteria enter the South Coastal watershed from a number of contributing sources under a variety of conditions. Activities that are currently ongoing and/or planned to ensure that the TMDL can be implemented are summarized in the following subsections. The *“Mitigation Measures to Address Pathogen Pollution in Surface Water: A TMDL Implementation Guidance Manual for Massachusetts”* provides additional details on the implementation of pathogen control measures summarized in the following subsections as well as additional measures not provided herein, such as by-law, ordinances and public outreach and education.

There are three major organizations in the South Coastal watershed that are working to improve water quality within the basin:

- The North and South Rivers Watershed Association (NSRWA) – The NSRWA seeks to identify sources of pollution to the watershed and remove the impact. The NSRWA also strives to educate the local population on issues surrounding their watershed (NSRWA 2005).
- The Massachusetts Bays Program (MBP) – The MBP, established in 1988, provides scientific research focused on determining and preventing pollution problems in the Bays. The MBP’s focus has expanded to include educating local officials through technical workshops. The MBP also provides training for volunteers to monitor storm water outfalls and swimming beaches (EOEA 2003b).
- The Massachusetts Office of Coastal Zone Management (CZM) – The mission of CZM “... is to balance the impacts of human activity with the protection of coastal and marine resources. As a networked program, CZM was specifically established to work with other state agencies, federal agencies, local governments, academic institutions, nonprofit groups, and the general public to promote sound management of the Massachusetts coast. CZM is funded primarily through the Commonwealth of Massachusetts, the National Oceanic and Atmospheric Administration (NOAA), and the U.S. Environmental Protection Agency (EPA).” (CZM 2005a).

Through the MBP, a Massachusetts Bays Comprehensive Conservation & Management Plan (MBP 2003) has been developed. This plan lists the following initiatives intended to protect and enhance shellfishing and the progress of these initiatives:

- Conduct three Sanitary Survey Training Sessions annually-one each on the North Shore, Metro Boston/South Shore, and Cape Cod-to educate local shellfish constables and health officers on the proper technique for identifying and evaluating pathogen inputs into shellfish harvesting areas (progress: full). Local partner: Division of Marine Fisheries
- Develop and administer a local Shellfish Management Grants Program to help communities finance the development and implementation of affective local shellfish management plans (progress: substantial). Local partner: Division of Marine Fisheries

- Continue and expand the Shellfish Bed Restoration Program to restore and protect shellfish beds impacted by non-point source pollution (progress: moderate). Local partner: Shellfish Bed Restoration Program
- Through the Shellfish Clean Water Initiative, complete an Interagency Agreement defining agency roles and contributions to protect shellfish resources from pollution sources (progress: new). Local partner: Office of Coastal Zone Management.

In 1990, Congress added the Coastal Nonpoint Source Pollution Control Program to the Reauthorization of the Coastal Zone Management Act. "This legislation gives states the opportunity to work with federal agencies and already existing programs to develop and implement enforceable measures to restore and protect coastal waters from NPS [nonpoint source] pollution. The legislation also gives states the flexibility to design measures that are both environmentally and economically sound. The Massachusetts Coastal Zone Management Office [CZM] and the Department of Environmental Protection [MADEP], in cooperation with a variety of other state agencies, are responsible for developing the Coastal Nonpoint Source Pollution Control Program for the Commonwealth." (CZM 2005b)

Through the Coastal Nonpoint Pollution Control Program, CZM is working with federal and state agencies, local officials, industry representatives, environmentalists, and the public to develop enforceable measures to restore and protect coastal waters from nonpoint source (NPS) pollution, which is currently the number one pollution problem in U.S. coastal waters. NPS pollution occurs when contaminants are picked up by rain water and snow melt and carried over land, in groundwater, or through drainage systems to the nearest waterbody.

Two grant programs administered by CZM support the implementation of the Coastal Nonpoint Pollution Control Program.

- The Coastal Pollutant Remediation (CPR) Grant Program, provides funding to municipalities in Massachusetts coastal watersheds to reduce stormwater impacts from roads, highways, or parking areas and to install municipal boat pumpout facilities.
- The Coastal Nonpoint Source Pollution (Coastal NPS) Grant Program complements CPR and addresses more general areas of nonpoint source control. These grants to municipalities, as well as other public and non-profit groups, can be used for the following types of projects: assessment, identification, and characterization of nonpoint sources; targeted assessment of the municipal stormwater drainage system (runoff from municipal roadways, parking lots and bridges); the development of transferable tools (nonstructural best management practices), such as guidance documents, model by-laws, and land use planning strategies to improve nonpoint source control and management; and the implementation of innovative and unique demonstration projects.

Both the CPR and Coastal NPS grant programs have been developed to provide resources to municipalities for assessing and managing nonpoint sources of pollution. Projects funded through these grants can stand-alone or they can be discrete components of multi-year projects. For example, a municipality might use Coastal NPS funds to identify pollution sources in a subwatershed during year one of a project, and then apply for CPR funds to develop best management practices to remediate the identified roadway related pollutants during year two. CZM encourages the incorporation of long-term, progressive pollution mitigation planning components into proposals for both programs.

Also as part of the Coastal Nonpoint Pollution Control Program, CZM developed the *Massachusetts Clean Marina Guide*. This reference for owners and operators of marine boating facilities provides information on cost-effective strategies and practices aimed at reducing marina and boating impacts on the coastal environment. (CZM 2005c)

For more information regarding CZM programs and grants, please visit their website at <http://www.mass.gov/czm/czm.htm>

7.2. Agriculture

A number of techniques have been developed to reduce the contribution of agricultural activities to pathogen contamination. There are also many methods intended to reduce sediment loads from agricultural lands. Since bacteria are often associated with sediments, these techniques are also likely to result in a reduction in bacterial loads in run off as well. Techniques generally include BMPs for field application of manure, animal feeding operations, barnyards, and managing animal grazing areas. Brief summaries of some of these techniques are provided in the *“Mitigation Measures to Address Pathogen Pollution in Surface Water: A TMDL Implementation Guidance Manual for Massachusetts”*.

7.3. Illicit Sewer Connections, Failing Infrastructure and CSOs

Elimination of illicit sewer connections, repairing failing infrastructure and controlling impacts associated with CSOs are of extreme importance. Implementation of the Storm Water Phase II Final Rule requires that municipalities detect and eliminate sewage discharges to storm sewer systems including illicit sewer connections (USEPA 2000). Implementation of this rule will thus help communities achieve bacteria TMDLs.

Guidance for illicit discharge detection and elimination has been developed by EPA New England (USEPA 2004c) for the Lower Charles River. The guidance document provides a plan, available to all Commonwealth communities, to identify and eliminate illicit discharges (both dry and wet weather) to their separate storm sewer systems. Although originally prepared for the Charles River watershed it is applicable to all watersheds throughout the Commonwealth. Implementation of the protocol outlined in the guidance document satisfies the Illicit Discharge Detection and Elimination requirement of the NPDES program. A copy of the guidance document is provided in Appendix A.

7.4. Storm Water Runoff

Storm water runoff can be categorized in two forms 1) point source discharges and 2) non-point source discharges (includes sheet flow or direct runoff). Many point source storm water discharges are regulated under the NPDES Phase I and Phase II permitting programs when discharged to a Waters of the United States. Municipalities that operate regulated municipal separate storm sewer systems (MS4s) must develop and implement a storm water management plan (SWMP), which must employ and set measurable goals for the following six minimum control measures:

1. public education and outreach particularly on the proper disposal of pet waste,
2. public participation/involvement,
3. illicit discharge detection and elimination,
4. construction site runoff control,
5. post construction runoff control, and
6. pollution prevention/good housekeeping.

Portions of towns in this watershed are classified as Urban Areas by the United States Census Bureau and are subject to the Stormwater Phase II Final Rule. This rule requires the development and implementation of an illicit discharge detection and elimination plan.

The NPDES permit does not, however, establish numeric effluent limitations for storm water discharges. Maximum extent practicable (MEP) is the statutory standard that establishes the level of pollutant reductions that regulated municipalities must achieve. The MEP standard is a narrative effluent limitation that is satisfied through implementation of SWMPs and achievement of measurable goals.

Non-point source discharges are generally characterized as sheetflow runoff and are not categorically regulated under the NPDES program and can be difficult to manage. However, some of the same principles for mitigating point source impacts may be applicable. Individual municipalities not regulated under the Phase I or II should implement the exact same six minimum control measures minimizing storm water contamination.

7.5. Failing Septic Systems

Septic system bacteria contributions to the South Coastal watershed may be reduced in the future through septic system maintenance and/or replacement. Additionally, the implementation of Title 5, which requires inspection of private sewage disposal systems before property ownership may be transferred, building expansions, or changes in use of properties, will aid in the discovery of poorly operating or failing systems. Because systems which fail must be repaired or upgraded, it is expected that the bacteria load from septic systems will be significantly reduced in the future. Regulatory and educational materials for septic system installation, maintenance and alternative technologies are provided by the MADEP on the worldwide web at <http://www.mass.gov/dep/brp/www/t5pubs.htm>.

7.6. Wastewater Treatment Plants

WWTP discharges are regulated under the NPDES program when the effluent is released to surface waters. Each WWTP has an effluent limit included in its NPDES or groundwater permit. Some NPDES permits are listed on the following website: www.epa.gov/region1/npdes/permits_listing_ma.html. Groundwater permits are available at <http://www.mass.gov/dep/brp/gw/gwhome.htm>.

7.7. Recreational Waters Use Management

Recreational waters receive pathogen inputs from swimmers and boats. To reduce swimmers' contribution to pathogen impairment, shower facilities can be made available, and bathers should be encouraged to shower prior to swimming. In addition, parents should check and change young children's diapers when they are dirty. Options for controlling pathogen contamination from boats include:

- petitioning the State for the designation of a No Discharge Area (NDA),
- supporting installation of pump-out facilities for boat sewage,
- educating boat owners on the proper operation and maintenance of marine sanitation devices (MSDs), and
- encouraging marina owners to provide clean and safe onshore restrooms and pump-out facilities.

There are currently no areas proximal to the South Coastal watershed established as "no discharge area" (NDA). This designation by the Commonwealth of Massachusetts and approved by the EPA provides protection of this area by a Federal Law which prohibits the release of raw or treated sewage from vessels into navigable waters of the U.S. The law is enforced by the Massachusetts Environmental Police. The Massachusetts CZM and Massachusetts Environmental Law Enforcement are actively pursuing an amendment to State regulations allowing for the institution of fines up to \$2000 for violations within a NDA (USEPA 2004a).

7.8. Funding/Community Resources

A complete list of funding sources for implementation of non-point source pollution is provided in Section VII of the Massachusetts Nonpoint Source Management Plan Volume I (MADEP 2000b) available on line at <http://www.mass.gov/dep/brp/wm/nonpoint.htm>. This list includes specific programs available for non-point source management and resources available for communities to manage local growth and development. The State Revolving Fund (SRF) provides low interest loans to communities for certain capital costs associated with building or improving wastewater treatment facilities. In addition, many communities in Massachusetts sponsor low cost loans through the SRF for homeowners to repair or upgrade failing septic systems.

7.9. Mitigation Measures to Address Pathogen Pollution in Surface Water: A TMDL Implementation Guidance Manual for Massachusetts

For a more complete discussion on ways to mitigate pathogen water pollution, see the "*Mitigation Measures to Address Pathogen Pollution in Surface Water: A TMDL Implementation Guidance Manual for Massachusetts*" accompanying this document.

8.0 Monitoring Plan

The long term monitoring plan for the South Coastal watershed includes several components:

1. continue with the current monitoring of the South Coastal watershed (local watershed conservation organizations, local governments, DMF),
2. continue with MADEP watershed five-year cycle monitoring,
3. monitor areas within the watershed where data are lacking or absent to determine if the waterbody meets the use criteria,
4. monitor areas where BMPs and other control strategies have been implemented or discharges have been removed to assess the effectiveness of the modification or elimination,
5. assemble data collected by each monitoring entity to formulate a concise report where the basin is assessed as a whole and an evaluation of BMPs can be made, and
6. add/remove/modify BMPs as needed based on monitoring results.

The monitoring plan is an ever changing document that requires flexibility to add, change or delete sampling locations, sampling frequency, methods and analysis. At the minimum, all monitoring should be conducted with a focus on:

- capturing water quality conditions under varied weather conditions,
- establishing sampling locations in an effort to pin-point sources,
- researching new and proven technologies for separating human from animal bacteria sources, and
- assessing efficacy of BMPs.

9.0 Reasonable Assurances

Reasonable assurances that the TMDL will be implemented include both enforcement of current regulations, availability of financial incentives including low or no-interest loans to communities for wastewater treatment facilities through the State Revolving Fund (SRF), and the various local, state and federal programs for pollution control. Storm water NPDES permit coverage will address discharges from municipal owned storm water drainage systems. Enforcement of regulations controlling non-point discharges includes local enforcement of the states Wetlands Protection Act and Rivers Protection Act; Title 5 regulations for septic systems and various local regulations including zoning regulations. Financial incentives include Federal monies available under the CWA Section 319 NPS program and the CWA Section 604 and 104b programs, which are provided as part of the Performance Partnership Agreement between MADEP and the EPA. Additional financial incentives include state income tax credits for Title 5 upgrades, and low interest loans for Title 5 septic system upgrades through municipalities participating in this portion of the state revolving fund program.

10.0 Public Participation

To be added later....

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Appendix A

Lower Charles River Illicit Discharge Detection & Elimination (IDDE) Protocol
Guidance for Consideration - November 2004